AGRIBUSINESS FACULTY MEMBERS' PERCEPTIONS OF IMPORTANCE AND INCLUSION OF DECISION SCIENCE TOPICS IN UNDERGRADUATE AGRIBUSINESS CURRICULA

A Dissertation

by

LAWRENCE ARTHUR WOLFSKILL

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

August 2011

Major Subject: Agricultural Leadership, Education, & Communications

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Approved by:

Chair of Committee,	Gary J. Wingenbach
Committee Members,	Timothy H. Murphy
	Theresa P. Murphrey
	James W. Mjelde
Head of Department,	Jack Elliot

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ABSTRACT

Agribusiness Faculty Members' Perceptions of Importance and Inclusion of Decision Science Topics in Undergraduate Agribusiness Curricula. (August 2011)

Lawrence Arthur Wolfskill, B.S., Texas A&M University;

M.B.A., Texas A&M University

Chair of Advisory Committee: Dr. Gary J. Wingenbach

Agribusiness degree programs train managers to make decisions in complex business environments. Curriculum designers generally look to the offerings of peer institutions for guidance. Decision science (DS) topics are important parts of agribusiness curricula and students should learn about these areas. Measuring faculty members' perceptions of the current inclusion and importance of teaching DS topics is a necessary step in developing a prioritized list of teaching needs. Leaving curriculum design to undocumented or random processes would be a poor start to training our nation's future agribusiness managers.

This research used a correlational *ex post facto* design to analyze faculty members' perceptions of topic importance and inclusion. A random sample of faculty members was emailed a link to an online four-part questionnaire. Forced Likert-type scales measured the perceptions of importance and inclusion of 18 selected DS topics. Gary Borich's model of weighted discrepancy scores was used to develop a rank order of DS topic curricular needs. Forced-entry multiple regression was used to describe how the variation in the dependent variables measuring perceived importance was partitioned among sets of predictor variables.

Teaching DS topics in a faculty member's coursework was significantly correlated with faculty members' overall perception of the importance of DS topics in the agribusiness curriculum, albeit at a low level. Although most dedicated DS courses were taught in agribusiness departments, no significant relationship existed between department and overall perceived importance of teaching DS topics. Faculty members who had earned a business degree did not rate DS topics as more important compared to those who had not earned a business degree. Respondents from departments with industry advisory councils did not rate the importance of DS topics higher than those from departments without such councils. Of the 18 DS topics studied, Project Management was identified as the one most needed to be added to agribusiness curricula. Forced-entry multiple regression was used for explaining variation among variables. Of the 18 importance-related dependent variables, those for Linear Programming and Material Resource Planning had no significant relationship with any independent variables. The remaining models explained at most 13.9% of the variations, and frequently much less.

DEDICATION

On April 28, 2008 I lost the ability to shake hands with my father and say, “Dr. Wolfskill, meet Dr. Wolfskill,” at least on this side of eternity. I am who I am in large part because of you, Dad, and what you have done in my life. You even went to the point of buying a ranch in Lolita, TX to teach your sons responsibility and the value of hard work. What great dividends that investment has paid! I love you, Dad.

Mom, you trained me up in the way I should go, always teaching and lovingly correcting, and I owe my life and my rebirth in Jesus to you. Thank you for everything, especially your prayers. I love you.

Mary, my loving wife. You encouraged, cajoled, worked, and put up with me for years, and without you I would not be receiving this degree, nor be anywhere near where I am in my life and career. I could not have done this without you. You have worn so many hats in this family, giving me time to retreat to the computer and work, and driving me back in there when I came out to do something not so important. There is no way I can adequately recognize what you have done for me. I love you so much!

ACKNOWLEDGEMENTS

Mere words cannot express my appreciation and thanks to all who have helped me in this rather long process. Dr. Gary Wingenbach, my committee chair, certainly ranks at the top. He chose to take a chance on me when I first applied to the program, and has helped me all the way through.

The rest of my committee, both in their committee roles and outside of that in class, the hallways, and in the office, have all done their part to mentor and guide me. To Dr. Tim Murphy, Dr. Theresa Murphrey, and Dr. Jim Mjelde: your support and direction have been irreplaceable.

Dr. Kim Dooley, although you were not on my committee, your encouragement and the way you modeled the role of mentor and professor will always motivate me. One of my goals is to be more like you.

To all my colleagues at Sam Houston, thank you for allowing me the time and scheduling leeway to complete this degree. I can't mention everyone, but I would like to especially point out Dr. Bobby Lane, who hired me as a lecturer way back in 2005, "rescuing" me from a decade and a half of life in Costa Rica. To Dr. Stanley Kelley, who took a chance on me and promoted me while ABD, and Dean Jamie Hebert, for your care and leadership, I am honored to serve on the same faculty as each of you.

To Michael and Linda Huff, Scott and Judy Hornung, and the rest of my Huntsville Community Church Vineyard family, your prayers have been the long-range artillery in this battle. I love you and appreciate all you do.

Peter Benchley may not have known me, but he nailed it when he said, “A man can do any amount of work, as long as it is not the work he is supposed to be doing at the moment.” Maybe he’d heard about me.

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CHAPTER I

INTRODUCTION

Improving the educational outcomes of degree programs is a primary goal of research in agricultural education. The food, agriculture, and natural resources sector is a dynamic area, with continually evolving technology and demographics. As a result, requirements for managers in agriculturally related businesses also continually change, both in technical knowledge and resource management abilities. Post-secondary curricula designed to prepare these managers must have periodic review to meet these changing demands (Sprecker & Rudd, 1997).

> A curriculum is not a thing but an evolutionary, dynamic process unique to the needs of individual institutions and their students. It is a process by which faculties create learning experiences for students and provide the mental discipline and motivation for life-long learning. We expect that this process will provide to students the basic concepts and methodologies on which they may build a career. (Williams, 1987, p. 49)

Although the term "curriculum" has been defined in many ways, most definitions are very similar (Clements, 2007). Here, the term will be defined as Clements explained, "a written instructional blueprint and set of materials for guiding students' acquisition of certain culturally valued concepts, procedures, intellectual dispositions, and ways of reasoning" (p. 36).

This dissertation follows the style of the *Journal of Agricultural Education*.

Undergraduate agricultural business programs have been gaining in popularity since their inception in the 1950s. These programs are a blend of business material, similar to traditional Bachelor of Business Administration (BBA) programs, but with an agricultural foundation that provides specific context for business coursework. In his commentary on the agricultural business degree curriculum, Manderscheid (1960) called for a "balanced professional program in business and agriculture," which should develop in its graduates "the basic principles of decision making, which serve as the basis for solving problems" (p. 1489).

As an integrated curriculum, the designers of agribusiness curricula endeavor to provide learning experiences that are cross-functional in scope. In this way, they serve to link the various business disciplines while making applications to the field of agriculture. Shoemaker (1989) classified an integrated curriculum as one that

> …is organized in such a way that it cuts across subject-matter lines, bringing together various aspects of the curriculum into meaningful association to focus upon broad areas of study. It views learning and teaching in a holistic way and reflects the real world, which is interactive. (p. 5)

Sonka and Hudson (1989) listed five characteristics of the agribusiness sector that distinctively set it apart from the traditional view of production. Briefly, they are (a) the unique aspects of food, both domestically and internationally; (b) production uncertainty due to biological processes; (c) issues of political intervention; (d) a technology development process that lies significantly in the public sector; and (e) differing competitive structures in the industry. The authors suggested that these characteristics unique to agriculture call for "specialized managerial skills and knowledge to facilitate efficient and effective decisions" within the sector (p. 308). The burden then falls on curriculum designers, faculty, and heads of the colleges and departments that offer these programs. They must decide how to balance the calls for general business knowledge integrated with agricultural concepts, and specialized business methodology and technical skills (White, 1990).

The decision to focus on specialized skills or integrated conceptual learning is not dichotomous. In theory, curriculum designers could plan both aspects into the offering, and develop a curriculum that is both integrated and specific. In practice, however, constraints (e.g., semester credit hour restrictions) lead to limitations. The fact is that curriculum designers must make essential choices in design and implementation when building agribusiness curricula.

One important choice for designers of agribusiness curricula relates to the inclusion of coursework in quantitative methods. Courses and programs in the field are frequently referred to as "Decision Science" (DS), "Management Science" (MS), or "Operations Research" (OR). For the purposes of this study, these terms were considered equivalent, and the term Decision Science (or DS) is used (cf. Yousef, 2009). Morse and Kimball (1951) defined the field as "a scientific method of providing executive departments with a quantitative basis for decisions regarding the operations under their control." Miller and Starr (1969) linked these terms by referring to OR as applied decision theory. While there are noteworthy differences in each of the terms, using one broad term to summarize the three expressions does not undermine the premise of the study (cf. Mingers, 2003, p. 559).

For curriculum and program designers (typically faculty members) to better develop agricultural business courses of study and meet the needs of employers hiring undergraduate agricultural business graduates, a better understanding of the factors affecting decisions relating to the inclusion of DS courses and topics is required. This study identified DS topics presently taught in undergraduate agribusiness curricula and the importance that faculty members placed on having those topics in the curriculum. Through the research process, a statistical model was developed that related the inclusion and importance of those topics. As Manderscheid (1960) concluded, "the basic fact remains: the professional component of the Agricultural Business program should be decision oriented" (p. 1491).

Statement of the Problem

Agribusiness programs endeavor to provide their industry constituents with a supply of well-trained, yet specialized professional managers who can make decisions in an increasingly complex business environment (Miller et al., 2006). Athavale, Myring, Davis, and Truell (2010) summed up the focus of these business-oriented types of degree plans when they noted, "meeting the evolving needs of businesses is imperative," (p. 5). While business school degree equivalents have a certification body–Association to Advance Collegiate Schools of Business (AACSB)–that ensures a level of standardization and exposure to content, the agribusiness curriculum has no equivalent entity. As such, colleges and departments with agribusiness programs show a wide variety of inclusion of technical areas such as decision science.

Apart from certification requirements, most curriculum designers look to institutional history and the offerings of peer institutions for guidance in specifying the required coursework. The history of decision processes for agribusiness curriculum choices, however, is not well documented. Further, the offerings of peer institutions do not show consistency in content inclusion choices (Boland & Akridge, n.d.). The field has much variety.

Previous research has identified that decision making and DS topics are important parts of agribusiness curricula, and students should receive teaching in these areas (e.g., Kao, Yeh, & Tsai, 1997; Manderscheid, 1960; Parker, 1973, Smith, 2003). As such, these topics merit consideration by curriculum committees and faculty members responsible for selecting the courses and topics that will be taught in undergraduate agribusiness degree programs. However, no list of topics is available that has been rigorously prioritized through the research process. Faculty members choosing such topics for inclusion look to other institutions, who likely made their choices by the same "looking around" process. Are we teaching the right topics to our students? How can we know which DS topics need more emphasis in undergraduate agribusiness curricula? Measuring faculty members' perceptions of the current inclusion and importance of teaching DS topics is a necessary step to developing the required prioritized list of teaching needs. Leaving curriculum design to undocumented and possibly even random processes would be a poor start to training our nation's future agribusiness managers.

Research Questions

This research study focused on modeling decision science topic penetration in US undergraduate agricultural business degree programs, as perceived by faculty members in those programs. Additionally, it sought to determine whether and how DS concepts were included in the curricula. It attempted to explain variations in agribusiness faculty perceptions relating to the importance of DS topics in the curriculum. It also described the variety of agribusiness undergraduate programs with respect to faculty characteristics. The following research questions guided the study:

1. What is the level of perceived importance of DS topics in agribusiness curricula?
2. What is the level of perceived inclusion of DS topics in agribusiness curricula?
3. How are DS topics included in the agribusiness curricula?
4. What are the priorities for design of the decision science portion of an undergraduate agribusiness curriculum?
5. Which of the collected faculty characteristics are related to a high level of perceived importance of DS topics?

Theoretical Base of the Study

Many researchers have developed models and frameworks for instructional design within individual courses. Among the notable versions are the ADDIE model (Grafinger, 1988), Kolb's Learning Cycle (Kolb, 1984), Bates' (1995) ACTIONS model, and Gagne's Nine Events (Gagne, Briggs, & Wager, 1992). While each of these serves an important purpose in guiding instructors in a logical, systematic methodology for designing effective instruction and evaluation, none of these have been applied directly to selecting courses and topics for inclusion in a course of study, and more specifically, an undergraduate degree plan. As such, the theoretical foundation for this research is an extension of a course-level model (Dick & Carey, 1996).

The Dick and Carey (1996) Instructional Systems Design Model uses a systems approach to learning that involves four key components: learner, instructor, instructional materials, and the learning environment. While it was initially developed for the more targeted application of designing specific instructional units, here it will be extended to designing at a more global scale, that of building overall curricula and degree programs. The relationship is comparable. One can design learning events for a course module, course modules for a specific course, or courses to fill a curriculum. In all cases, the model they proffer serves to guide in the selection and development of the parts. As a systematic process, the stages have a natural order.

Dick and Carey's (1996) model divides the process of determining content into ten distinct stages. These stages target specific skills and knowledge to be attained or attitudes to be changed. Figure 1 displays the model with the linkages from one stage to another.

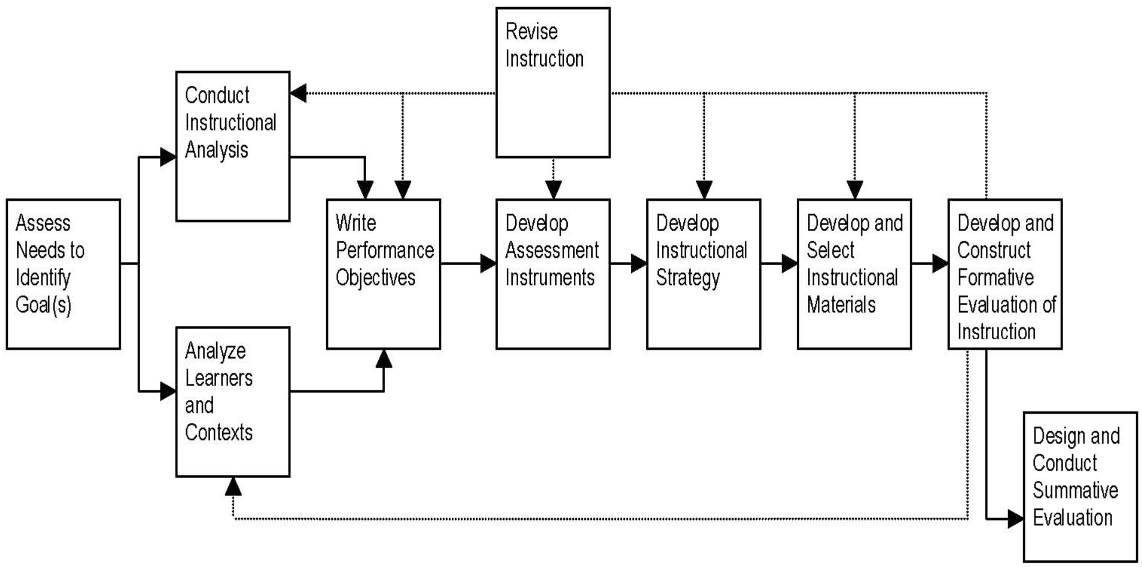

Figure 1. The Dick and Carey instructional systems design model. From *The Systematic Design of Instruction*, by W. Dick and L. Carey, 1996, New York: Harper Collins.

The first step in the model relates to needs assessment. Fitzpatrick, Sanders, and Worthen (2004) described needs assessment in terms of questions that establish first, “whether a problem or need exists and describing that problem,” and second, “making recommendations for ways to reduce the problem” (p. 21). Needs assessment with respect to instructional design, then, relates to identifying whether there are discrepancies between the knowledge, skills, and traits the learners have prior to the educational event, and those that are desired for a trained individual. Without an accurate and comprehensive determination of what the proposed instructional unit is to accomplish, Dick and Carey's model will fail to provide the expected outcome of instruction that will prepare learners for their future tasks, jobs, and careers. As such, a proper needs assessment is crucial to designing instructional systems.

Russell and Trede (1999) adapted several extant models into an Input-Process-Product format (figure 2), and tailored it specifically for designing an urban agricultural education program. They patterned it primarily after Tyler's (1949) model, and included ideas and concepts from several classes of curriculum models. One class of models, the vocational training curriculum models (Curtis, 1978; McCrory, 1992; McNeil, 1990; Schnellert, 1993) addresses the training of learners in the specific tasks required to gain a high level of technical competence in the occupation that the learners are expected to pursue. As such, they are not sufficient for a university level undergraduate education. Russell and Trede also included aspects of a futuristic model (McNeil, 1990), which includes preparing students to face a future workplace that may be very different from the current situation. Finally, Russell and Trede added aspects of a needs assessment model which aids in prioritizing goals and targeting limited resources (McNeil, 1990). According to Dick and Carey (1996):

> Need assessment is the most important element in the instructional design process. The more that is known about competencies needed in agriculture careers and is incorporated into curriculum development, the more employable agriculture graduates will be in the marketplace. Additionally, the input from

employers would provide a benchmark against which future students would be compared and serve as an assessment indicator. (pp. 67-68)

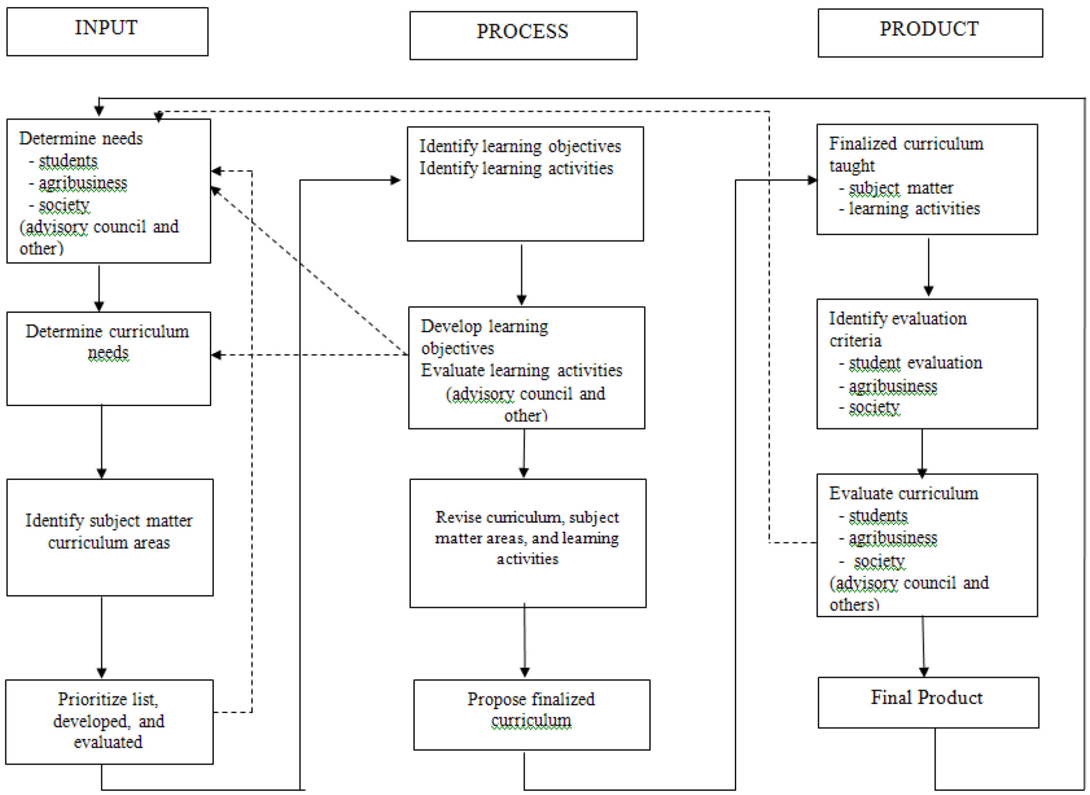

Figure 2. Curriculum development for an urban agriculture education program. From "Developing an urban agriculture education program: A proposed model." by D. Russell and L. Trede, 1999, *Proceedings of the 26th Annual National Agricultural Research Conference*, p. 260. Copyright 1999 by the American Association for Agricultural Education. Solid lines depict the flow of the model; dashed lines denote evaluation feedback.

The Russell and Trede process begins in the input stage, where the needs of students, the agribusiness industry, and society in general are identified and analyzed. An advisory council made up of relevant stakeholders (faculty members, students, business representatives, etc.) performs this task. After needs identification, subject matter areas are explored which meet the identified needs. Through a process of analyzing the subject matter areas, lists of possible curriculum topics are developed and prioritized. As a part of this process, decisions are made as to whether specific areas should be included in courses, or as part of other courses, based primarily on the preferences of stakeholders. Russell and Trede were not specific in the methods that could be used to perform these analyses and make the decisions, leaving particular techniques to the discretion of the implementers. However, it is important that final decisions and topic lists be compared to the results of the needs analysis previously performed.

From the resultant topic list, learning objectives and teaching plans are developed in the process phase of the model. The advisory council and stakeholders build the proposed final curriculum through the identification and evaluation of specific learning objectives and activities. Once the curriculum completes the process stage, Russell and Trede's product stage begins. In this stage, the finalized curriculum is taught and a method of evaluation is developed. Student input is included in identifying the criteria to be used for evaluation, and the advisory council makes the final determination on what will comprise the curriculum.

Several key aspects are included in the model that may not be clear in the diagram. The dashed lines indicate that the results of formative evaluation events feed back into the process in an iterative manner. As seen, these evaluations can lead to changes with effects all the way back to the beginning of the input process.

With respect to the methodology, the present research study was based on Baker and Trussell's (1981) theory, as cited in Kitchel, Cannon, and Duncan (2009), that "the gap between theory and practice could be eliminated by reducing theory to what was needed to perfect the practice (teaching)" (p. 176). Identifying this gap as it applies to DS topics in agricultural business curricula can be done by surveying the faculty members responsible for those curricula, using Borich's Needs Assessment Model. Borich (1980) described educational needs in terms of the discrepancies between what a student was capable of doing and what the educational goal in that area was. He proposed that by measuring and analyzing these discrepancies, and mathematically weighting them based on their perceived importance, a prioritized list of educational outcomes could be developed. These prioritized outcomes could then become the basis for educational programs and program improvements. In Borich's model, subjects are asked to rate the degree to which they perceived themselves able to complete specific tasks, along with the importance of those identified tasks. The collected data show perceptions of what actually is, and what is desired, for the learners with respect to key topics.

Borich's (1980) model can be used to evaluate an educational program and determine which parts require reinforcement, and what training areas should be increased to augment the knowledge and abilities of the learners. Borich's stated intention was that the procedure be used to evaluate both preservice and inservice training. Many research studies have been performed using this model; most of them have been in the area of agricultural teacher training needs assessment (e.g., Duncan, Ricketts, Peake, & Uesseler, 2006; Joerger, 2002; Layfield & Dobbins, 2002; Myers, Dyer, & Washburn, 2005; Peake, Duncan, & Ricketts, 2007; Roberts & Dyer, 2004; Robinson, 2006; Robinson, Garton, & Terry, 2007). Zarafshani and Alibaygi (2008) used a Delphi technique to identify 19 teaching and learning competencies, which they coupled with the Borich methodology to evaluate inservice training needs for agricultural faculty at an Iranian university. They highlighted the fact that the results of the Borich methodology "can be linked to a practical decision framework to improve a training program" (p. 349).

Purpose of the Study

The purpose of this research study was to understand the perceived importance of teaching DS topics in undergraduate agricultural business curricula, and determine how the teaching of those topics has been addressed by the various entities responsible for curriculum design in colleges and universities in the United States. Further, the study determined the curricular needs perceived by the faculty teaching agribusiness topics, and developed a model of the areas of decision science topics that were most needed to be added to the curriculum.

Significance of the Study

The purpose of undergraduate education in business courses of study is to better prepare students to effectively work in and manage businesses (Abraham & Karns, 2009). Decision science topics allow and encourage students to systematically understand business situations and apply processes to improve decision making. Better decisions should lead to better outcomes for their businesses. Results of this research study aid curriculum designers in understanding the decisions that others have made concerning the level of penetration of DS topics and courses in undergraduate agricultural business degree programs. Understanding what others have chosen to do should allow the development of better courses of study for departments desiring to enhance their students' agribusiness management and decision making skills.

By adding to the available research literature, colleges and universities determining the appropriate level of DS penetration in their curricula will be able to understand the depth of diffusion that DS has reached in their peer organizations, and have a model for what the current faculty believe to be needed. Additionally, this study identified areas of research that could be fruitful in further understanding the significance of the teaching of quantitative methods in agribusiness curricula.

Operational Definition of Terms

For the purpose of this research study, the following definitions are used, with their abbreviations, where appropriate:

Curriculum: "A written instructional blueprint and set of materials for guiding students' acquisition of certain culturally valued concepts, procedures, intellectual dispositions, and ways of reasoning" (Clements, 2007, p. 36). For this study, the focus will be on the concepts (more specifically, DS topics) which are transmitted to students through the undergraduate educational process in four-year agribusiness degree programs in the United States.

Decision Science (DS): A scientific method used to aid decision makers in understanding decision-making scenarios, inputs, and outcomes, which provides a quantitative basis for making operational decisions. DS processes are typically based on modeling techniques. DS is very similar to Operations Research (OR) and Management Science (MS), and the terms are sometimes used interchangeably.

Mean Weighted Discrepancy Score (MWDS): A calculated value which relates one characteristic of a topic, such as ability, achievement, or in this study, inclusion, to its perceived importance, yielding a prioritized ranking of the topics.

Perceived Importance: The perceived importance of a specific topic is defined as the mean score on a 4-point Likert-type scale. Each topic is rated 1 (not important), 2 (somewhat important), 3 (important), or 4 (extremely important). An individual score above the mean of the scale would show that the respondent placed greater importance on the value of that topic in an undergraduate agribusiness degree program than others in the study.

Perceived Inclusion: The perceived inclusion of a specific topic is defined as the mean score on a 4-point Likert-type scale. Each topic is rated 1 (not included), 2 (not adequately included), 3 (adequately included), or 4 (very much included). An individual score above the mean of the scale would show that the respondent perceived that the topic was included in that faculty member's undergraduate agribusiness degree program to a greater extent than others in the study.

Specific Topics in Decision Science: Eighteen variables were used to evaluate decision science topics in agribusiness curricula. These topics were identified through a review of curricula in current agribusiness programs. The topics used were: (a) forecasting; (b) regression analysis; (c)descriptive statistics; (d)inferential statistics;

(e)probability and distributions; (f) z-scores; (g) linear programming; (h) project management; (i) inventory management; (j) analytic hierarchy process; (k) simulation; (l) material resource planning; (m) total quality management; (n) decision tables and rules; (o) decision trees; (p) expected monetary value; (q) game theory; and (r) statistical process control.

Topic Areas in Decision Science: The 18 DS topics were condensed into three topic areas, based on the methodology and use of each. A panel of agribusiness faculty members divided them into the areas of Statistical Methods, Business Applications, and Optimization. A discussion of the division is found in Chapter III.

Limitations of the Study

Several potential limitations have been identified. One primary issue is that of faculty members actually knowing what topics are included in courses taught by their peers. In many cases, faculty members may not have a good working knowledge of course content for classes that are not their own responsibility unless, perhaps, they also advise students. Additionally, results may be limited by the honesty and integrity of the respondents. Responses about perceived importance may be skewed based on whether the respondent is biased with respect to the topic. It is possible that faculty members actively teaching DS topics will respond more favorably than those who are not teaching DS topics. Dillman (2007) observed that while respondents who answered self-administered questionnaires were typically very honest, the social desirability factor leads some to answer in the manner they think the surveyor wants them to answer.

Dawis (1987) noted that response bias operates in every instance where respondents are asked to rate items on any scale. The bias may relate to level, where the respondent tends to place the mean rating in a particular part of the overall scale, whether high (leniency), low (strictness), or in the middle (central tendency). Dispersion bias is the tendency to use only a small part of the complete scale (whether central or extreme), or to spread responses out over the complete range available. Correlation bias exhibits through the "halo effect," where several items, variables, or scales are highly correlated with one another. Unfortunately, it is difficult if not impossible for the researcher to determine whether such correlation is due to bias or to the true ratings of that individual.

A further limitation of this study came as a result of the particular software that was used to collect the online data. The survey was designed to collect data about degree programs through questionnaires completed by faculty members within those programs. Questions related to program characteristics that were easily found were not asked of the respondents. However, the data collection program stripped the identifiers from the records so it was not possible to match responses with the program from which they came. As a result, inferences related to characteristics such as department or university size and number of faculty members could not be made.

Organization of the Remainder of the Dissertation

Following this introduction, Chapter II presents a review of the literature pertaining to DS topics in agribusiness curricula and their relationship to business school curricula. Chapter III describes the methodology used for the present study. Chapter IV includes the results of the analysis of data and a discussion of the findings. Finally, Chapter V summarizes the research project, providing conclusions, recommendations, and the implications of the results.

CHAPTER II

REVIEW OF THE LITERATURE

The permanent literature has few direct references to the decision making processes that curriculum designers have used to develop courses of study in agricultural business. The term “curriculum” has been defined to include “establishing educational objectives, program content and teaching method” (Schroeder 1988, p. 218). Barnett, Parry, and Coate (2001, p. 436) asserted that “curricula will be shaped in significant degrees by the values and practices of the different knowledge fields.” The impact that universities have on students is in large measure based on the chosen curriculum (Barber, 2000). Agrawal, Sharma, and Kumal (2008) asserted that a curriculum is even more all-encompassing, consisting of all elements in a learning environment that encourage intellectual, personal, social, and physical growth, including “lessons, extracurricular activities, approaches to teaching, learning and assessment, the quality of relationships within institute [sic], and the values embodied in the way the Institute operates” (p. 885).

However, college curricula have another important purpose. They are a window for the outside world of stakeholders to see what educational objectives are important to the faculty. It is faculty members that actually choose curriculum parts, whether in concert with industry councils or not. Faculty members develop the material that makes up the individual courses that comprise the curriculum. In essence, faculty members have the most, and perhaps in most cases complete, control over the topics and subtopics that are actually presented to the students in a college curriculum. In 1952, Hofstadler and Hardy (as cited in Barber, 2000) wrote:

> A college curriculum is significant chiefly for two things: it reveals the *educated community's conception* [emphasis added] of what knowledge is most worth transmitting to the cream of its youth, and it reveals what kind of mind and character an education is expected to produce. (p. 11)

While Hofstadler and Hardy's comments of six decades ago may or may not still be true in today's situation, it is evident that faculty members have much control over the curriculum (Blank, 1987), and would be expected to choose content that they believe is "worth transmitting" in their teaching field.

Mayhew and Ford (1971) proffered nine postulates as a base for a theory of curriculum. Their fifth postulate proposes that any curriculum's purpose is to make changes in the students, and move them in directions that are socially desirable. These directions should meet the needs of society in general, and more specifically those of the clients of the educational system. They also warned that while this goal may sound like indoctrination, it simply lines up with the goal of all education: that of moving a student from one point to another. A well-designed curriculum has the added feature of being able to describe the planned or expected outcome of the educational intervention in advance.

When Yale University (2005) reviewed the requirements for all undergraduate students in every course of study in the university, the distinguished panel concluded:

> The mental rigor resulting from quantitative study has been celebrated for as long as formal education has existed, and applications of quantitative methods have proven critical to an astonishingly wide range of disciplines.... An educated person must be able to make, understand, and evaluate arguments on the basis of quantitative information. (p. 5)

Designing a curriculum, however, is a challenge with many competing considerations. Each program must balance the curricular offerings through a process that involves not only determining what competencies are necessary for a graduate to possess, but also how much emphasis to give each relative to the others (Passow, 2008). In developing or reviewing an agribusiness curriculum, many look to the offerings of peer institutions, in effect asking, "What does everyone else do?" (Harris, Miller, & Wells, 2003; Savin, Longer, & Miller, 2005).

Curriculum Comparisons

Several studies are available that compare the curricula of various agricultural economics and agricultural business programs in the United States. However, most of these are dated (Harris et al., 2003), and typically group courses into general categories that may obscure the specific course content offered. Carman and Pick (1986) performed a well-cited survey of 55 departments containing agricultural economics, agribusiness, or both majors. They classified each required course into one of twelve broad categories and made comparisons of credit-hour requirements for each category of coursework. Later that year Franklin (1986) reported on the study of 43 North American agricultural economics departments. The researcher surveyed the departments specifically for information on calculus, statistics, and computer courses, along with selected economics and agricultural economics courses.

A decade later Larson (1996) completed a similar survey of 43 schools offering agribusiness programs of study, through an analysis of then-current course catalogs (college bulletins). Listed courses were divided into six categories: (a) Math, Statistics and Computer; (b) Written and Oral Communication; (c) Humanities, Social Sciences and International Understanding; (d) Agricultural Economics, Economics and Business; (e) Technical Agriculture and Natural Resources; and (f) Science. The principal change he found over the decade was a greater emphasis on business skills, with a concurrent reduction in technical agriculture skills.

Boland, Lehman, and Stroade (2001) reviewed course offering material from 112 agribusiness programs through Internet search, email, and postal mail. They categorized required and elective courses into three broad categories: marketing, management, and other. They further sub-classified the courses based on specific content, using textbook choices to aid in classification. However, they made the decision not to categorize coursework in quantitative methods because there was such variability in offerings across their sample.

Competencies and Skills for Success in the Workplace

University coursework exists for a basic reason: to develop the student into the type of graduate that the university or division within the university has determined that it desires. Fundamentally, courses are the units used to impart knowledge to, and develop skills in the student. While many would agree that the reason for imparting such knowledge and developing the given skills is to prepare students to be valuable members of the workforce in their chosen profession, this line of reasoning has been a topic of much debate over the history of US colleges and universities. Erven (1987) posited that the “primary vehicle for curricular change” (p. 1037) is intrinsically tied to the faculty members’ vision of what exactly an educated person is. He affirmed that faculty members control and choose curriculum, and therefore the curriculum reflects what the faculty values.

Daniel (1998) wrote a comprehensive history of upper level business education, and particularly the Masters of Business Administration course of study. In it he outlined the changes within higher education that led to modern schools of business. Early universities were very much places where students learned to be good, cultured citizens through a liberal education, including philosophy, languages, and literature. “Trade school” topics such as business were considered too vocational for a university to teach (Risi, 2005). The response of academia to business courses of study was summed up by Daniel:

> Traditional colleges reacted in horror to any suggestion that they should allow commercial subjects to intrude into the classical curriculum. Colleges were for learning, not earning; colleges were to teach how to think, not how to do; … colleges were guardians of the accumulated wisdom of centuries, not training grounds for new skills. (p. 28)

Through the efforts and funding of Joseph Wharton and many who followed, business education has taken its place in universities in a manner similar to other professional career tracks such as engineering, law, and medicine. Still a subject of debate, however, was the question of what specifically to teach in business courses of study. Kurz and Bartram (2002, cited in Bartram, 2004, p. 247) studied the competencies that were required for business, identifying 112 primary abilities through content analysis of many published competency models. They then mapped these competencies onto 20 dimensions, which were further consolidated to eight factors, which they called “The Great Eight Competencies.” Two of these eight key competencies, “Leading and Deciding” and “Analyzing and Interpreting” were related to the DS processes. Brightman and Elrod (2000) condensed the required knowledge of managers and leaders into the phrase, “problem solving and decision making are among the most important skills a manager must possess” (p. 5).

Many stakeholders contribute to the dialog that is used to determine the “correct” set of courses and topics to include in a given curriculum. As noted above, research has been conducted to determine which topics and themes university curriculum committees have decided to include in the past. Other research (e.g., Blank, 1987; Martin, Milne-Home, Barrett, Spalding, & Jones, 2000; Parker, 1973; Preston & Broder, 1990; Radhakrishna & Bruening, 1994; Riesenberg, 1987; Robinson, 2006) queried recent graduates to determine their perceptions on what has been valuable in finding and succeeding in employment. These studies generally identified soft business skills such as communication and management as most important, and frequently lacking in current curricula. Radhakrishna and Bruening (1994) found that employees valued interpersonal and communication skills, desiring more curricular emphasis in such topics. Technical agriculture themes were consistently ranked as less important than managerial and decision making knowledge, skill, ability, and trait areas (KSATs) for the agribusiness graduates. Riesenberg (1987) specifically identified decision-making capabilities as one of the areas most needing more curricular emphasis. Blank (1987) noted that faculty and alumni generally agree about the areas of greatest curricular need, but one area where alumni placed more emphasis than faculty was that of "quantitative methods/decision making" (p. 32).

Preston and Broder (1990) used cluster analysis to relate graduates' skill sets to income, describing the market's valuation of the various sets of skills. The skill sets "Business and Economic Skills" and "Computer, Quantitative, and Management Information" ranked substantially higher than "Technical Skills," which was made up of scientific agricultural KSATs. Robinson and Garton (2008) surveyed recent agribusiness graduates on their perceptions of the importance and competence of career-related KSATs. They then used a Borich (1980) needs assessment model to determine areas in the curriculum that could be enhanced to better prepare students in their program.

A third set of stakeholders, the employers of agribusiness graduates, have been the subject of numerous studies. Robinson and Garton (2008) related that employers commonly believe that the purpose of higher education is to prepare future employees for the workplace by instilling the appropriate skills. Blank (1987), however, noted that curricular need perceptions of people working in industry often differ substantially from those of the faculty members that deliver the curriculum. Employer surveys have a long history of attempting to identify which KSATs are valuable for new employees (Andelt, Barrett, & Bosshamer, 1997; Brand, 2005; Broder and Houston, 1986; Cole & Thompson, 2002; Graham, 2001; Klein, 1990; Litzenberg & Schneider, 1987; Miller, Fredendall, Ferreira, & Nilson, 2006; Shuayto, 2001; Wood, 1947). Some researchers have surveyed both employers and recent employees and compared the experiences (e.g., Suvedi and Heyboer, 2004).

Citing several research studies, Wallace, Smith, and Hagen (1994) summed up employers' desires for KSATs in new hires:

> Beattie observed industry wants analytic-problem-solving skills, general education and communication skills. Conley emphasized the difference between school skills and workplace skills. School requires taking notes, reading assignments, and passing exams. The workplace requires skills in critical reading, transforming data into information, decision-making, and communication. As noted by Barkley, "Agricultural economics alumni earned higher current salaries than those in animal sciences, implying that there is some value to the blending of agriculture, business skills, and economic principles." (p. 1202)

Identifying Curricular Needs

Educational resources are both valuable and limited, and according to general economic theory, such scarce resources should be allocated cautiously. The system used for determining what the specific needs are, and how they should be prioritized, must be carefully chosen (Edwards & Briers, 1999). Throughout the years, various direct and indirect methods have been used to ascertain educational needs.

Bach (1958) attempted to identify the needs of business curricula through a qualitative, informal look at where he believed the trends were pointing. Shinn, Briers, and Baker (2008) used a classical Delphi method with “engaged scholars” (p. 123) as subjects, to describe the knowledge set that doctoral students in agricultural education should have. Boyd (2004) noted that the Delphi technique has been used in the field of agricultural education mostly in curriculum development, but that it also is used in many other fields to determine which competencies are essential.

McGarry Wolf and Schaffner (2000) used a multiphase research approach, with secondary research to identify both the needs of the California agribusiness industry and the characteristics of programs offered by peer institutions. They followed this with primary research to identify specific skills and courses needed for the program being developed at their university. They used a panel composed of faculty members and agribusiness executives (members of an advisory council) to identify curricular needs. Interestingly, the curriculum committee in their study affirmed the preeminence of the faculty members over industry by including all of the top thirteen topics that the faculty ranked, which were only eleven of the fourteen top-ranked topics of the industry council.

Savin, Longer, and Miller (2005) documented a curriculum redesign process that was based on several inputs. First, the redesign committee members studied other respected programs that had a similar emphasis. They developed matrices of topics that could be included in their own program, and from these generated lists of goals and topics that they considered important for their curriculum. Faculty members were then asked to evaluate the identified goals and topics, and rate them on how well their current courses included them, and how important they believed the topics to be. Through the process, faculty members were able to highlight curricular areas needing emphasis.

Waters and Haskell (1989) used a modified Borich needs assessment model to identify and prioritize staff development training needs of a cooperative extension faculty. They stated, "The Borich model ... seems to have merit for adding validity to the process of assessing respondents' perceptions about the importance of educational program needs" (p.26).

Borich (1980) described educational needs in terms of the discrepancies between what a student was capable of doing and what the educational goal in that area was. He proposed that by measuring and analyzing the difference between these, a process he called “discrepancy analysis,” educational programs would be able to be evaluated. Through this evaluation, a prioritized list of educational outcomes could be developed. These identified educational outcomes could then be emphasized when developing training or new learning events. Borich’s model asks subjects to rate the importance of identified topics, as well as the degree to which they are perceived to be attained by the learners. The collected data are used to determine what actually is, and what is desired, for the learners.

While Borich originally designed his method to have the subjects (in most cases, new teachers) respond to the survey by evaluating statements with respect to the importance of, and their abilities in, certain specific performance objectives, he recognized that his model allowed for modification and expansion (McKim & Pope, 2010). These two authors noted that the Borich model permitted ratings on two dimensions, and that they were not constrained to importance and competence. The model could use other characteristics that would aid in determining where discrepancies exist, and thus identify needs in a training program.

Several researchers have extended the Borich model through adapting parts of it to meet specific needs. Robinson, Garton, and Terry (2007) used the method with supervisors of agricultural graduates as respondents. Through the Borich method they developed a list of 23 topics that could be modified in the undergraduate curriculum, which would enhance the value of the graduates. In order of priority, they were: (a), solving problems (b), setting priorities (c), functioning well in stressful situations (d), recognizing alternative routes in meeting objectives (e), identifying problems (f), identifying potential negative outcomes when considering risky venture (g), prioritizing problems (h), allocating time efficiently (i), making decisions on the basis of thorough analysis of the situation (j), recognizing the effects of decisions made (k), responding positively to constructive criticism (l), adapting to situations of change (m), managing/overseeing several tasks at once (n), identifying essential components of the problem (o), sorting out the relevant data to solve the problem (p), understanding the needs of others (q), working well with fellow employees (r), assessing long-term effects of decisions (s), initiating change to enhance productivity (t), communicating ideas verbally to groups (u), gaining new knowledge from everyday experiences (v), meeting deadlines and (w) resolving conflicts.

Wall (2010) used a modification recommended by Briers and Edwards (1998) and split the respondents, having the beginning teachers complete the competence portion of the questionnaire, while a panel of agricultural education experts completed the importance portion. Those researchers then used a modified matrix analysis to evaluate the discrepancies. Wu and Li (2009) used the Borich needs assessment model to evaluate undergraduate curricula in departments of information management and business administration with respect to courses and topics in e-commerce. They surveyed recent graduates and had them evaluate the knowledge level and importance of various information resources topics. The researchers also revised the Borich process by identifying each instance where a respondent listed minimal or no understanding of a topic (lowest level on the Likert-type scale), and removing that importance level from the importance average calculation. They justified the method with the assumption that a respondent with little to no understanding of a topic could not properly rate its importance. Wood (2010) evaluated Defense Department program managers' competencies to identify systemic weaknesses in the training. Using the Borich model, he surveyed experienced private defense industry managers to assess the KSATs of their government project manager counterparts. Because the private and government project managers typically worked very closely together, Wood believed that this survey method would aid in reducing the bias associated with self-surveys.

No researcher to date has evaluated the results of the Borich model using regression analysis. A review of the literature has revealed very little use of regression in the area of curricular design. One reason could be that most survey research into curricular design yields nominal or ordinal data, and Ordinary Least Squares (OLS), the most common type of regression analysis, is not suitable for these types of dependent variables. Logit, probit, and ordinal logistic regressions could be used, but curricular studies using these methods were not found in the literature. Mean Weighted Discrepancy Scores (MWDS), however, are ratio-level continuous data, and would be suitable as dependent variables in an OLS regression analysis, provided the other assumptions are met.

One important use of regression analysis is in explanation of variation in dependent variables (Pedhazur, 1982). Explaining variation is the process of dividing explanatory power (as measured by R^2) into segments derived from specific groups of explanatory, or independent, variables. Using the statistical process with curriculum data could provide insight into which independent variables are related to high needs or desires in curricular design, and possibly in identifying limiting factors in a program or faculty. The real challenge, then, would be in the practical realm, developing a model that would reasonably explain why identifying such limiting factors would have practical importance. Pedhazur noted that the "meaningfulness" of a result is more important than statistical significance.

History of Agribusiness Programs and Curricula

Departments of Agricultural Economics began to offer business-oriented curriculum versions in the 1950s (Manderscheid, 1960). The first agribusiness MBA degree was offered in 1972 at the University of Santa Clara (Margherita Secundo, & Taurino, 2009). Parker (1973) noted that in the Agricultural Economics degree program she studied (University of California, Davis), surveys of current students and recent graduates identified the business related, problem-solving orientation of the degree program to be a strong attribute. Miller et al. (2006) reviewed several studies regarding stakeholder perceptions of agricultural graduates and concluded that perhaps the current agribusiness curriculum does not emphasize the qualities that employers value most. Quoting from the Klein (1990) study, they stated that if their conclusions were correct,

> they may raise questions about the appropriateness of our educational methods. If, for example, we stress the acquisition of knowledge at the expense of teaching students how to think and react in a problem solving context, we may not be preparing students for successful employment in the contemporary business environment. (p. 3)

According to Miller et al. (2006), agribusiness graduates receive relatively low mean assessments for their "ability to make decisions in the face of incomplete information and risk" (p. 8). When Snyder (1969) profiled the Purdue agribusiness program, he highlighted the fact that "the undergraduate curriculum emphasizes basic management principles and techniques useful in the managerial decision-making process" (p. 1218). In discussing problems and progress, he linked the issues the curriculum was experiencing to a shortcoming in integrating related-discipline topics into the management decision-making process.

Wysocki et al. (2003) studied the issues surrounding the quantity and kinds of marketing courses offered in undergraduate agribusiness curricula. The authors identified three areas that are the primary drivers for the selection of courses in a curriculum. First, the courses offered must be relevant to the skills required in the job market. Second, the curriculum mix must be viable in the sense that students must desire to enroll, and employers must desire to hire those students, each based on the coursework and perceived rigor of the program. Finally, faculty must be available and willing to teach the courses. He concluded, “The challenge is to adjust teaching resources and curricula to better reflect current and emerging priorities in agriculture” (p. 198).

Relationship of Business School Curricula to Agribusiness Curricula

The business school literature is replete with references to curricula targeted or focused on particular industry segments. Linton (2002) cataloged business programs with emphases in aviation, engineering, environmental sciences, food, industrial distribution, the hospitality industry, real estate, risk management, and others. In most cases, these specialized degree programs are oriented as a business degree with a functional area specialization. However, various programs have the reverse orientation: a functional degree with a general business curricular emphasis. Examples include engineering degrees with a management emphasis (Dannelly & Garrison, 2008), hospitality and/or tourism industry degrees with a business focus (Miranda, 1999), architecture degrees with increasing business emphasis (Abdullah, 2007), and the focus of this study, agricultural business degree programs which use the agricultural industries as a framework for teaching business courses. Sonka (1989) noted that the viability of business programs in the agricultural sector depends on how well those programs can develop business managers who have a competitive advantage in handling the unique aspects of the agricultural sector.

One can view agribusiness degree programs as business courses of study with strong specializations in agricultural industry. Royer (2007) commented on the similarities of the agricultural economics and business disciplines that make up agribusiness programs, and contrasted such programs to most of the agricultural, life science, and natural resource disciplines. Both agribusiness and business programs, for example, have a low degree of paradigm development, in contrast to other life science programs. Biglan (1973a) defined the level of paradigm development as the degree to which the department encompassed fields that have a common body of theory that is subscribed to by all members. Departments with a high level of paradigm development, then, tend to have a tight educational focus and set of common theory; an example would be physics. A department with a low level of paradigm development would be a social science such as psychology or education, where many different theories in many different areas are subscribed to and researched by faculty members of the same academic department.

Royer (2007) identified four distinct areas where agricultural economics is more closely related to the business disciplines than other agriculture or natural resource program areas. Briefly, they are: (a) perceived level of academic productivity; (b) academic department culture (level of intra-faculty dissention, curriculum content consensus, etc.); (c) level of funding from both internal and external sources, and related to this, teaching load levels, support staff sizes, and staff salaries; and (d) differing number of upper level administrators from that discipline. Royer noted that academic departments with low degrees of paradigm development are considered "worse off" in many respects. He did note, however, "teachers in low-consensus disciplines are more apt to teach their students critical thinking skills" (p. 3). Biglan (1973b) compared department structure and scholarly output and came to similar conclusions.

Boland et al. (2001) expected agribusiness degree programs to hold to similar standards as those outlined by AACSB, with applications that specifically relate to the technical agriculture and food areas. Therefore, while a logical curriculum development process is not evident in the literature on agribusiness, it follows that studying those processes as they occur in courses of study in colleges of business could be insightful.

Decision Science in Business School Curricula

Within colleges of business, industry needs have influenced the business curriculum from the early stages (Campbell, Heriot, & Finney, 2006), including its emphasis on producing managers who can operate in a business environment, making and implementing decisions. Business curricula have been available options as majors in colleges and universities in the US for many years. Risi (2005) cited historical articles that note the establishment of business curricula as early as 1881, with the Wharton School of Finance and Economy at the University of Pennsylvania. Prior to the Wharton School's creation, dedicated business schools had existed, but were generally apprentice-based, and typically called *commercial colleges*. Their courses of study were normally clerical, and did not produce managers or leaders, but rather bookkeepers.

Decision making coursework has long been a formal part of curricula in the business school in the US (Smith, 2003). Kao, Yeh, and Tsai, (1997) stated more specifically that operations research and management science topics have been considered indispensible for many years. They studied Asian business schools and business culture to determine how much of the western-style DS coursework had penetrated the Asian school curricula and whether teaching methodologies were modified to better fit the Asian culture. The authors also identified that the two primary benefits of DS coursework were related to the objectives of improving students' general quantitative skills, and improving the ability of the students to think logically.

As early as 1958, Bach discussed the importance of looking a quarter century into the future and predicting business situations, and the resultant curriculum needs, that would prepare then-current undergraduate students for the middle- to upper-management roles and responsibilities they would have at that future time when they would actually be in the position of key decision makers in business. Understanding that most graduates of business schools would have perhaps two decades (Bach's estimate) before they reached general manager responsibilities, he laid out a framework for a business curriculum that would prepare the students for such an environment. He noted that a key part of the curriculum was coursework on fundamental analytical tools and quantitative methods, and their applications in identifying, solving, and implementing decisions on managerial problems. In fact, he opined that the organizing focus for the entire business management curriculum should be based in management decision making and the implementation of those decisions.

Accreditation in Business and Agribusiness Curricula

In the US, two business school accreditation organizations are recognized by the Council for Higher Education Accreditation (CHEA). The Association to Advance Collegiate Schools of Business (AACSB) has a greater focus on research in its accreditation process, while the Accreditation Council for Business Schools and Programs (ACBSP) is directed at teaching institutions that have less of a research emphasis or mission (ACBSP, 2009).

The AACSB was established in 1916 as the American Assembly of Collegiate Schools of Business, and had as one of its charges to manage a system of accreditation for US business degree programs. It later changed its name to the Association to Advance Collegiate Schools of Business. AACSB has been recognized by the U.S. Department of Education as the premier accrediting agency for undergraduate and graduate business schools (Buttermore, 2010).

With regard to the relevancy of curriculum, AACSB (2010) has made this recommendation in its Accreditation Standards:

> For business degrees, the business community provides valuable information about critical skills and knowledge for graduates. Major employers and corporate advisory groups give information about the situations most faced by graduates and view the learning goals of the school from the perspective of persons who must put knowledge into practice on a daily basis. They also may provide insight into trends and anticipated demands on graduates, thus assisting in curricular revision toward future needs. (p. 62)

In describing learning expectations for bachelor's level degree programs, the association highlights several specific areas. Among these knowledge and skill areas are "intellectual ability to organize work, make and communicate sound decisions, and react successfully to unanticipated events" (AACSB 2010, p. 57).

However, AACSB has changed the way it has approached the decision sciences over time. Before 1991, AACSB required specific coursework in management science. Between that year and 2003 the accreditation organization began generalizing its requirements, in the sense that it stopped listing specific topics in many areas, including the decision sciences. Instead, topics that would normally be taught in a business management program are listed, but it is left up to individual schools to choose the topics they will include (Markowski, 2008). AACSB permits this freedom of choice, as long as the school demonstrates that its coursework is "current and relevant to the needs of business and management positions" (p. 1).

The AACSB does not accredit programs (including agribusiness) that are located outside of colleges of business. At the present time, there is no accreditation body that certifies such degree programs. Boland and Akridge (2004) suggested that for agricultural business degree programs, a model program or course of study should be developed, perhaps by a well-known agricultural economics organization. This could enhance agreement among departments and programs as to what constitutes a sound agribusiness program. Boland and Akridge did not go so far as to recommend a specific agribusiness accreditation system, noting that universities already expect programs to specify learning outcomes and measure the success in achieving them. The authors indicated that maintaining local control over program details would allow each program to identify and serve the niche market it chooses.

Industry advisory councils are used as input for many degree programs. The AACSB (2010) has recommended, but not mandated, that each business program have such a council to help curriculum committees maintain and update curricula. The Association for Computing Machinery (ACM), which provides guidelines for information systems degree programs, recommends the use of industry advisory councils for degree programs in those fields (Campbell, Cover, Hawthorne, & Klee, 2004). The ACM advocates industry involvement in curriculum as part of their guidance on sustaining programs. The organization suggests that colleges commit to build "industry involvement through an industry advisory committee empowered to influence decisions and impact the program" (p. 2).

Summary of the Literature Review

The decision making processes for selection of DS content in agribusiness curricula is not well-documented in the literature. While numerous studies catalog the actual content in varying degrees of detail, reasons and methods for selecting that which is taught are not apparent. Generally, university curriculum committees that would initiate or update an agribusiness curriculum would look to peer institutions and ask, "What are others doing?"

Various researchers have documented a general history of how business topics became available as areas of study in universities. Early on, such topics were considered too vocational for university study, but with time and much effort, business programs took their place among other professional courses of study such as engineering and medicine. Agribusiness degree programs, as business-type degrees superimposed over technical agriculture frameworks, are a recent addition to the set of choices, having their start out of agricultural economics departments in the 1950s.

Several classes of stakeholders have a vested interest in the curricular content of agribusiness programs. Faculty members, university administrators, agribusinesses hiring the graduates, and of course the students themselves each have specific requirements and expectations for what will be taught in the degree program. However, while research has shown that each of these groups can have input into the curricular decision making processes, it is the teaching faculty who actually select the topics that are presented in classrooms.

One area of study within the range of business topics that can be taught is that of decision science. Many studies of each of the key stakeholder groups have identified management decision making and analytical topics as highly important skills and knowledge for agribusiness graduates to have. Additionally, in many of the studies the ability level of graduates was deemed lacking. Several methods are extant for identifying curricular needs; the present study used the Borich needs assessment model to develop a prioritized ranking of DS topics for agribusiness curricula based on the perceptions of faculty members in those departments.

Regression analysis is a common statistical method for identifying and quantifying the correlations among independent and dependent variables. It has not, however, been found in the literature as a method for analyzing curriculum.

CHAPTER III

METHODOLOGY

This chapter describes the processes used to develop the instrument, manage the data collection process, and analyze the data. IRB approval for the research design was requested from the Texas A&M University Institutional Review Board under request number 2010-0356. Approval for exempt status was granted on May 20, 2010. Official notice of the approval can be found in Appendix A.

Research Design

This research used a correlational *ex post facto* design. Correlational research is most appropriately used when the researcher wishes to describe the degree to which two or more quantitative variables are related (Fraenkel & Wallen, 2006). Correlational research is widely used in educational research (Ary, Jacobs, & Razavieh, 2002). Ary et al. suggested that "information gained from such correlational studies is especially useful when trying to understand a complex construct or to build a theory about some behavioral phenomenon" (p. 25). They noted that the interpretation of correlations in this kind of study should include sample size, correlation coefficient value, and both the statistical and practical significance of the findings.

The present study employed the causal-comparative method to describe and explore the possible relationships that may exist among demographic and descriptive variables for the faculty members and departments, and the importance, inclusion, and methodology for the teaching of DS principles. The causal-comparative design is an appropriate research methodology, based on Gall, Gall, and Borg's (2007) conclusion that one advantage of the causal-comparative method is that it allows for the study of cause-and-effect relationships where experimental manipulation is not possible. However, Gall et al. noted a disadvantage in that "inferences about causality on the basis of the collected data are necessarily tentative" (p. 310). The resultant conclusions may suggest causality, but in fact there may be no or even reverse causality from that which is hypothesized.

To perform the assessment of the 18 DS topics, a variation of Borich's (1980) model was employed. Faculty members in four-year undergraduate agribusiness degree programs were surveyed. Perceived importance for each topic was compared to perceived inclusion in the course of study using the mean weighted discrepancy score (MWDS) that Borich developed.

Research Objectives

Based on the research questions, the following more specific research objectives were developed:

1. Describe how DS topics are included in the various curricula represented by the sample.
2. Evaluate the perceived importance of the DS topics and topic areas with respect to faculty and program characteristics, and develop a rank order of level of importance.
3. Evaluate the perceived inclusion of the DS topics and topic areas with respect to faculty and department characteristics, and develop a rank order of level of inclusion.

4. Develop a rank order of teaching priority of the 18 identified DS topics, and the three DS topic areas, using Mean Weighted Discrepancy Scores (MWDS).
5. Determine the faculty and department characteristics that explain variations in the perceived importance of DS topics in the curricula.

Sample Selection

The population under consideration consists of departments in US colleges and universities that offer four-year undergraduate degrees in Agricultural Business (or similarly named courses of study). The frame used for identifying schools was based on a search of the US Department of Education's Institute of Education Sciences' Internet site, College Navigator (National Center for Education Statistics, n.d.). The site is searchable for all degree programs in US public and private institutions of higher learning. From this search, 111 institutions were identified that offer four-year degree-granting programs in any of the following fields: Agribusiness/Agricultural Business Operations; Agricultural Business and Management, General; Agricultural Business and Management, Other; Agricultural Business Technology; and Agricultural Economics. To guard against frame error from the College Navigator database, an online search of the relevant keywords was also performed using a popular Internet search engine. This search yielded another 16 institutions, bringing the total to 127.

The survey methodology used in this research study belongs to a class called *Internet Survey of Specifically Named Persons* (American Association for Public Opinion Research [AAPOR], 2011). Such samples include important assumptions that should be clarified. These assumptions include (a) the request or invitation to participate is sent electronically, (b) only the person specifically named and invited is an eligible participant (i.e. invitations are not to be passed to colleagues, etc.), (c) all persons in the frame have Internet access, and (d) confirmation is necessary that the respondent is in fact the named person (this confirmation may be implied). Under this class, any invitation sent that has no response (and is not returned as undeliverable) must be considered a valid nonresponse, unless it can be otherwise confirmed that the recipient was not an eligible frame member. The AAPOR also classifies the present study as an *Establishment Survey*, as opposed to a *Household Survey*. Establishment surveys have a specialized method for defining and revising target participants within the establishment. Such procedures include considering the establishment as the sample unit, while the respondents provide the survey information.

Probabilistic sampling was used on the population to select the subject institutions. Faculty members were considered an intact group within population units, so cluster sampling was appropriate for this type of study (Ary et al., 2002). The instrument was targeted to two classes of faculty members in each candidate department: the chairs (heads) of these departments, and the faculty members who actually teach or have recently taught agribusiness coursework. While it is expected that on average, two to three faculty members will respond from each surveyed institution (one department head and one or two subject area faculty), each department could have more or less. The receipt of at least one usable questionnaire from any institution will allow for the experience of that institution to be captured. According to Dillman (2007), for an institutional population of this size (127) with an acceptable amount of sampling error of 5% and a confidence level of 95%, a random sample of 96 institutions is required.

To identify faculty members in the agribusiness departments in the sample, several sub-frames were used for the purpose of limiting coverage error of the frame. The researcher visited the departmental websites of each of the selected institutions to discover the email address of the departmental chair (or head). Initially, an email (included in Appendix B) was sent to each of the department chairs briefly describing the study and asking for a list of the appropriate faculty members' names and email addresses. Of the 96 department chairs contacted, 26 (27%) responded with candidates. Additionally, the researcher contacted the American Association of Agricultural Economics and received a list of members who self-selected Agribusiness as a field of interest. From these, all names not associated with an email address from an educational institution (.edu) were deleted. This remaining list was later narrowed to only those with an email address from an institution within the sample. Finally, the researcher visited the faculty listing web pages of each of the 96 selected institutions to add any faculty members that may have been missed. After identifying each candidate from the universities selected in the sample, a total of 646 faculty members were included in the initial emailing.

Instrumentation

Descriptive-correlational research frequently uses interviews and questionnaires to collect information from participants (Ary et al., 2002). For this study, the instrument used for data collection (Appendix C) is a researcher-developed, four part questionnaire.

Dillman’s (2007) methodology was used to develop the instrument and design the entire data collection process. Internet survey methods are used based on the evidence reported in Ladner, Wingenbach, and Raven’s (2002) study of Internet and paper-based data collection methods. The authors studied Web-based and traditional paper-based survey modes and found that, while the paper based survey methodology had more overall surveys returned, the Web-based mode was substantially faster in returning valid surveys, “an important factor in conducting cost- and time-effective research” (p. 46).

The four objective instrument parts elicit responses concerning: (1) the relationship of DS coursework to the student’s major; (2) the faculty member perceptions of inclusion and importance of 18 selected DS topics in the curriculum; (3) the level at which the faculty member integrates DS topics into his or her courses; and (4) demographic and professional information on the participants. These parts of the questionnaire require respondents to select their responses from researcher-provided alternatives. This structured format helps keep subjects on task, takes less time to complete, and is relatively easy to analyze (Best & Kahn, 1993). The perception section uses a four point forced Likert-type scale.

Forced Likert-type scales have an even number of possible responses, rather than the more typical odd number with a neutral position. They are useful when there is a likelihood of many respondents with a less intense belief about the subject. Respondents who select a middle-or non-committal-response do not necessarily respond to the question in the same manner as those who must choose one side or the other through the use of forced scales (Moors, 2008). This response-style behavior can introduce nonrandom response error. Kieruj and Moors (2010) noted that they found many researchers who reported that the addition of a neutral response "attracts subjects disproportionally to this category" (p. 323). However, they also found that using an even number of responses in Likert-type questions versus including a center (neutral) choice could lead to midpoint response style bias, where respondents tend to avoid selecting extreme choices. They concluded that based on their research and literature review, there is no conclusive evidence that response style behavior varies systematically with the presence or absence of a middle response option, and that more research is needed in the area.

Pilot Testing of the Instrument

A pilot study was performed using selected faculty from the Agribusiness and Agricultural Education sections of the Department of Agricultural and Industrial Sciences at Sam Houston State University, Huntsville, TX. That institution was then excluded from the possibility of being selected in the sample. Each of the six faculty members was given the instrument, with instructions to complete it as if that person had been selected as a respondent. Additionally, they were asked to make specific comments on wording, navigational helps, usage issues, and any other notes that may be helpful in improving the instrument. They were further asked to provide perceptions on the face and content validity. Based on the comments, no content improvements, and only minor layout improvements were made to the instrument. These faculty members also formed a panel that categorized the 18 DS topics into three areas for measuring internal consistency. In Table 1 the 18 topics are shown sorted into their groupings.

Table 1

Decision Science Topic Area Categorization

Business Applications	Statistical Methods	Optimization
Forecasting	Regression Analysis	Linear Programming
Project Management	Descriptive Statistics	Analytic Hierarchy Process
Inventory Management	Inferential Statistics	Simulation
Material Resource Planning	Probability and Distributions	Expected Monetary Value
Total Quality Management	Z-Scores	Game Theory
Decision Tables and Rules	Statistical Process Control	
Decision Trees		

The Statistical Package for Social Sciences for Windows, Version 17 (SPSS) procedure *Reliability Analysis* was used to determine the internal consistency of the measurement scales. Measures for each set of associated Likert-type scale responses were developed by summing the attitudinal scales making up each grouping. Each of the three attitudinal scales was found to be reliable, as measured by Cronbach's (1951) alpha coefficients. A benefit of using Cronbach's alpha is that it can measure the reliability of a test through analysis of a single administration of the test. "Cronbach's alpha is the average value of the reliability coefficients one would obtained [sic] for all possible combinations of items when split into two half-tests" (Gliem & Gliem, 2003, p. 84). Tuckman (1999) reported that for attitude tests, reliabilities should be at least .50. While some researchers have written that alpha levels should on the order of .80 or higher, Ary et al. (2002) concur with Tuckman that for research and certain other purposes, lower reliability coefficients are acceptable. The inter-scale reliabilities of the instrument for each grouping are shown in Table 2. The minimum level of Cronbach's alpha is .70, for the importance construct of optimization, indicating that the instrument has sufficient internal reliability.

Table 2

Cronbach's Alpha Reliability Estimates of the Perceptions of Decision Science in Agribusiness Curricula Instrument

Topic Area	Inclusion	Importance
Business Applications	.85	.85
Statistical Methods	.84	.83
Optimization	.74	.70

Note. Cronbach's alpha level above .50 are generally considered sufficient for survey-based educational research.

Validity and Reliability

All questionnaire-based research instruments have the potential for introducing measurement error. To minimize the impact of possible error, the instrument was evaluated with respect to validity and reliability. Carefully composing an electronic letter with appropriate directions and details, as well as using design and layout procedures that have been validated through appropriate research methods (Dillman, 2007) aids in minimizing measurement error.

Internal and external validity can be serious threats to the ability of a consumer of research to extrapolate results to other populations. Internal validity is the assumption that the instrument actually did measure what was intended (Ary et al., 2002). According to those authors, it is "the most important consideration in developing and evaluating measuring instruments" (p. 242). Internal validity has two key parts: face validity and content validity. Face validity suggests that the instrument appears valid for its intended purpose. Content validity suggests that the questionnaire measures what it purports to measure. As noted above, pilot testing was used to enhance content and face validity of the instrument.

External validity allows the results of a study to be extrapolated to other populations. Factors such as sampling error, selection error, and frame error influence external validity. These errors are mitigated through carefully planning and executing the sampling plan (Radhakrishna & Doamekpor, 2008). However, nonresponse error may still be a valid threat to external validity (Dillman, 2007). Responses were coded for timing of return, and a comparison of early and late responses was used for evaluation (Lindner, Murphy, & Briers, 2001; Miller & Smith, 1983).

Data Collection

Data were collected using a web-based questionnaire. All communications were performed through email. Appendix B contains samples of each email communication. Identified department heads from each institution were emailed a short description of the study with a request to email back names of the faculty members in their organization that teach agribusiness courses. Communications generally conformed to the process outlined in Dillman (2007). The communications plan is shown in Table 3, with the type of email message sent, as well as the timeline of its sending using the actual invitation with link to the questionnaire website as Time 0. Two additional messages were sent at the end of data collection. First, a request was sent to those candidates who had started the questionnaire and had saved an in-process version, but had not submitted it.

Additionally, a final communication to a sample of nonresponders with a subset of questions was sent for the purpose of evaluating nonresponse error.

Table 3

Survey Communications Plan

Communication	Day
Request to Department Heads	-28
Prenotice	-2
Initial Invitation	0
1st Reminder	2
2nd Reminder	8
3rd Reminder	18
Request to finish already started questionnaire	25
Nonresponse Request	35

Note. Days are measured from the initial invitation to participate in the study that included a link to the questionnaire. The total time from the first to the last communication was 63 days.

The names of all the faculty members identified from the schools in the sample were listed in an Excel 2007 file. Each was then assigned a random code consisting of two uppercase letters followed by three digits, generated using a researcher-developed Excel function. These ID codes were then checked to ensure that no duplicates existed. The ID code was used as a login on the survey so that the survey collection software could identify which candidates had not responded, so as to preclude the sending of reminders to respondents who had submitted their questionnaire. This also helped ensure that a respondent did not pass the survey link to other faculty members not in the respondent pool. The mailings were accomplished by merging the email addresses from Excel 2007 to letters written in Microsoft Word 2007 by utilizing the email merge process. These individual emails were passed by the Word 2007 program to Microsoft

Outlook 2007 and sent through the Texas A&M University server to the survey candidates. Permission was requested and received in advance from Texas A&M Computer Services to allow the volume of messages to pass their server without triggering the mailing as outgoing spam.

Research and Null Hypotheses

Based on the research questions and objectives, four specific hypotheses were tested.

Research Hypothesis 1: Respondents who teach DS topics will place more importance on the teaching of such subjects than those who do not teach DS topics in their coursework.

Null Hypothesis 1: No significant difference exists between respondents' perceptions of the importance of DS topics in the agribusiness curriculum relative to experience in teaching DS topics and courses.

Research Hypothesis 2: Respondents from departments that teach DS topics within their own department, rather than sending students to another department for the material, will place more importance on the teaching of such subjects.

Null Hypothesis 2: No significant difference exists between respondents' perceptions of the importance of DS topics in the agribusiness curriculum relative to whether the course is taught within the department or not.

Research Hypothesis 3: Respondents with at least one earned degree from a college of business will place more importance on the teaching of DS topics.

Null Hypothesis 3: No significant difference exists between respondents' perceptions of the importance of DS topics in the agribusiness curriculum relative to type of earned degree of the faculty member.

Research Hypothesis 4: Respondents from departments that have an industry advisory council will place more importance on the teaching of DS topics.

Null Hypothesis 4: No significant difference exists between the respondents' perceptions of the importance of DS topics in the agribusiness curriculum relative to the presence of an advisory council.

Data Analysis

The data collection program was designed to automatically strip identifiers and put all data into an Excel spreadsheet before the researcher could access it. After closing the data collection process, the researcher utilized version 17 of the Statistical Package for the Social Sciences (SPSS) statistical software to transfer the data into a usable electronic form for that program (.SAV format). Discrepancy data were included by adding a variable for each of the 18 DS topics included, and setting it equal to the signed difference between the inclusion and importance data values for each respondent. A Weighted Discrepancy Score (WDS) variable was then added for each respondent for each item by multiplying the discrepancy score by the importance score. Additionally, for each respondent the inclusion and importance responses on the 18 DS topics were averaged over each of the three DS topic areas, yielding six more variables: the discrepancy scores for each DS topic area.

The nominal and ordinal data generated from the survey were tabulated to show frequencies and analyzed using SPSS. The SPSS procedures *Frequencies* and *Descriptives* were used to calculate central tendencies, frequencies, and variability of variables. The SPSS procedure *Bivariate Correlations* was employed to evaluate the significance of correlations between the importance and inclusion scales to identify relationships to faculty demographic and program characteristic variables, using Pearson's r correlation procedure. An alpha level of .05 was established *a priori* to determine statistical significance.

In this research study, two constructs were measured by the dependent variables: importance and inclusion of each of the 18 DS topics. As these variables were ordinal in scale, they were not suitable for using the ordinary least squares (OLS) regression methodology. These two variables were combined mathematically to form a third, derived set of dependent variables, the WDSs for each grouping of DS topics. The WDS variable was on a ratio scale, allowing for OLS regression analysis. Additionally, there were various independent variables: the descriptors of the faculty members and degree programs in the sample. For each independent variable, univariate analysis was first conducted, which served the purpose of describing the survey population.

Both the Dick and Carey (1996) and Russell and Trede (1999) models begin with the process of using an analysis of needs to identify instructional goals. On a curricular level, this relates to identifying the knowledge outcomes that the student is expected to gain through the process of completing the degree program. One common needs assessment method widely used in education is the Borich model, which calculates a weighted discrepancy score to identify which items of interest are valued more than they are implemented (Edwards & Briers, 1999). The Borich mean weighted discrepancy score (MWDS) gauges perceived need through measuring that gap. In this study, the MWDS indicated whether the faculty members' perceptions of the importance of DS topics aligned with the incidence of those topics actually being included in the coursework.

Forced-entry multiple linear regression was used to identify the characteristics of programs and faculty members as they relate to explaining the variation in the perceived importance levels of the DS topics. Forced-entry multiple regression permits a researcher to include all independent variables that are correlated with the dependent variable in the multiple regression model. Each independent variable can then be evaluated for the significance of its *t*-value, and insignificant ones could be removed. A follow-on multiple regression analysis would identify the amount of variation (change in R^2) accounted for by the resultant list of independent variables. In this sense, R^2 is a measure of the "proportional reduction in error" (Demaris, 2004, p. 54), indicating how much better (less error) the model is than a model not containing the independent variable set. The overall goal of research is to understand phenomena. Using multiple regression analysis to explain variance aids more in understanding a phenomenon than using the procedure for prediction (Pedhazur, 1982).

Neither forced-entry multiple linear regression nor explanation of variation were found in the literature to have been used in curricular studies. Thus, this part of the research has been classified as exploratory. Jaeger and Halliday (1998) discriminate between *confirmatory research*, and *exploratory research*. Confirmatory research evaluates one or more alternative hypotheses, gained from a base of literature, in an attempt to make strong inductive inferences as to whether such hypotheses can be refuted. In contrast, exploratory research is an attempt to identify relationships such that hypotheses might be generated. It is important to note that more rigorous statistical analysis may be necessary in follow-on studies to test specific hypotheses derived from the more general relationships identified herein.

Human Subjects Review Process and Informed Consent

Federal and Texas A&M University rules require any research design that involves human subjects be reviewed by the appropriate institutional review board (IRB). The research methodology proposed in this research design involves polling faculty members for their perceptions, which characterizes it as human subject research. This research was submitted for exemption from the full review process on the basis of the survey/interview procedure, which had no or minimal expected negative consequences for subjects. Approval from the review board was obtained prior to administering the research instruments.

Subjects were provided with informed consent information through the entry page on the website that hosted the questionnaire. They were not required to sign the consent form, as that signature would be the only document that linked each individual to the study. Participants were advised that: (a) their participation was voluntary, (b) no personally identifiable information would be collected, (c) there were no known risks, benefits, or compensation to participants, and (d) the study would be used for research and data would be published in group form only. Appendix D shows the information that was presented to potential subjects on the website entry page.

Summary of Research Methodology

This research used a research design that is common in educational research. The correlational *ex post facto* design allows a researcher to describe the degree to which quantitative variables are related. The causal-comparative method was used to explore the relationships among demographic and descriptive variables for the faculty members and departments, and the importance, inclusion, and methodology for the teaching of DS principles. Borich's (1980) model of weighted discrepancy scores was used to develop a rank order of DS topic curricular needs, based on the perceived inclusion and importance of the topics by the faculty members responding.

A random sample of four-year degree granting programs at US universities was drawn from the research frame. Of the 127 identified institutions, a sample size of 96 was required to ensure no more than 5% sampling error and a confidence level of 95%. From the sampled institutions, candidate faculty members were identified through various means, in keeping with the *Establishment Survey* methodology. Department heads (chairs) and faculty members who actively teach in the agribusiness program were selected to receive a series of email communications introducing the research project, asking for the faculty members to navigate to a website and complete the questionnaire, reminding nonresponders, and finally asking a sample of the nonresponders to complete a pared-down version of the questionnaire. In all, up to eight communications were made with survey subjects, as outlined in Table 3.

The instrument contained four parts, which allowed respondents to provide information on (1) the relationship of DS coursework to the student's major; (2) the faculty member perceptions of inclusion and importance of 18 selected DS topics in the curriculum; (3) the level at which the faculty member integrates DS topics into his or her courses; and (4) demographic information. Forced Likert-type scales were used for the perception portion of the instrument. A pilot study was performed, and minor changes were made to the instrument. Additionally, the pilot study panel recommended categorizing the 18 DS topics into three areas for measuring internal consistency. Cronbach's alpha reliability estimates were calculated for the three areas, in both the inclusion and importance constructs. The six alpha reliability estimates ranged from .70 to .85, all within established norms for a reliable instrument.

Statistical analysis of the data was performed using SPSS version 17. Appropriate frequency, central tendency, and variability measures were calculated to describe the responding faculty members and the departments and programs they represented. Inferential statistics were evaluated at an a priori established alpha level of .05. Multiple linear regression analysis was used to describe how variation in the dependent variables measuring perceived importance was partitioned among sets of predictor variables. Forced-entry multiple regression was initially used to identify the set of variables that were statistically significant predictors for each importance dependent variable. Then multiple regression was administrered again to determine how much variation was explained by the set of independent variables.

This research design and process was evaluated by the Institutional Review Board at the Texas A&M University Office of Research Compliance. It was approved with exempt status under IRB # 2010-0356. Appendix A contains a copy of the compliance notification from the IRB, and Appendix D contains the human subjects protection information that was presented to potential participants on the website entry page.

CHAPTER IV

RESULTS

This chapter reports the findings of the research process and the data analysis. The purpose of the study was to evaluate the perceived inclusion and importance of selected DS topics and identify factors related to a high perceived need to be added to the curriculum. The study sought to describe the agribusiness faculty members and programs represented by the sample. It further sought to develop a ranked order of the perceived need for adding specific course topics in decision science to agribusiness curricula. Faculty members reported individual and departmental characteristics and their perceptions on the current inclusion and importance of 18 DS topics.

This chapter is organized into nine sections. The first three sections discuss the response to the survey, the effects of nonresponse on the results, and the description of the survey participants. After that, five sections discuss the results of the five research objectives, providing descriptive and inferential statistics and results of hypothesis testing where appropriate. The chapter concludes with a summary of the results.

Sample Response and Attrition

Respondent attrition occurred at each step of the data collection process. Of the 646 faculty members contacted, 24 removed themselves from the study after the prenotice, generally citing reasons that related to errors in the sampling frame, such as being in an extension or full-time research position. Additionally, after each subsequent mailing, some candidates removed themselves from the study including: (a) after the initial invitation (n = 16); (b) after the first reminder (n = 16); (c) after the second reminder (n = 7); and (d) after the third reminder (n = 21). Five subjects were removed because of unresolvable email addresses; another candidate was deceased. In all, of the 646 agribusiness faculty members selected, the final sample contained 556 subjects.

Of the 556 sampled subjects, 320 submitted an online questionnaire, for a response rate of 57.6%. However, some questionnaires were unusable, and others were only partially usable, depending on the portions that the respondent chose to answer. Nineteen respondents (3.4% of final sample) submitted questionnaires that were completely empty. These were deleted from the dataset, leaving 301 (54.1%) complete or partial responses. Overall, 23 faculty members who submitted questionnaires did not answer any questions beyond the first page, and the decision was made to eliminate them from the dataset and consider them as nonresponders. As a result, the final count of respondents based on valid and usable complete and partially complete questionnaires was 278 (50.0%).

Data from respondents who completed both the inclusion and importance rating of any DS topic were used for calculating mean inclusion, mean importance, and WDS for that particular topic. Of the 278 submitted questionnaires, 259 (93.2%) contained at least one valid ranking pair from the 18 possible. Additionally, 238 (85.6%) ranked 17 of the 18 pairs, and 203 (73.0%) ranked all 18 pairs. Further, of the 278 valid submissions, 15 (5.4%) did not make rankings for any of the 18 inclusion variables, 7 (2.5%) did not rank any importance variables, and 4 (1.4%) respondents did not make rankings for any of the 36 primary dependent variables, those of inclusion and importance of the 18 individual DS topics. These respondents were left in the dataset, however, because they had answered other questions that aid in understanding the population characteristics, and the statistical software can correctly handle missing values.

Nonresponse Analysis

Nonresponse error can be a threat to external validity. It occurs when there is a difference between sampled subjects who respond to a survey and the subjects who do not respond (Dillman, 2007). It is important to the degree that such differences limit the generalizability of the results of the research from the sample to the population, and to other populations. Dooley and Lindner (2003) noted that to be able to generalize from sample to population, at least 50% response rate is required, and the researcher must address nonresponse.

Tuckman (1999) concluded that if the survey response rate is less than 80%, the researcher should try to reach 5 to 10% of the nonrespondents and acquire at least some response. Lindner et al. (2001) recommended three methods that could be used to evaluate nonresponse error. They further stated that if the response rate were less than 85%, at least one of the methods should be used. The three methods they suggested were (a) compare early to late respondents, where the last wave of thirty respondents were considered the late respondents; (b) run a regression using "days to respond" as dependent variable, and other key variables as independent variables; and (c) sample at least twenty nonrespondents in a separate contact for comparison with respondents. According to Lindner et al., any of these methods are defensible and generally accepted procedures for evaluating nonresponse error to determine whether it constitutes a threat to external validity.

For this study, all three methods were considered. Unfortunately, the software used to capture completed surveys did not report information that could be used to calculate a "days to respond" variable, so the regression method suggested by Lindner et al. (2001) could not be used. A random sample of 31 nonrespondents was contacted by email and asked to complete an attached, pared-down version (Appendix E) of the original questionnaire. This limited questionnaire contained one question from each of sections 1, 2, and 4, and four of the original 18 DS topics (section 3) for evaluation. This set of questionnaires was to be used to determine whether any systematic differences were evident between nonresponders and responders, as recommended by Lindner et al. However, of the 31 contacts only three were willing to complete even the shortened form of the questionnaire. As a result, statistical analysis of nonresponse error was not effective using the nonrespondent survey.

The method that was able to be used was the comparison of early and late respondents. Miller and Smith (1983) identified that there is a similarity between nonresponders and late responders, such that late responders could act as a proxy for nonresponders and be compared to early responders. Radhakrishna and Doamekpor (2008) concluded that the results of the sample analysis may represent the population if significant differences between early and late respondents on key variables are not found. As such, nonresponse error for this study was evaluated through early/late comparison. The first 32 (10% of the actual number of questionnaires submitted) respondents were compared to the last 32 respondents that provided valid submissions, to determine if any statistically significant differences were evident, using an independent samples t-test. For this study, non-response bias was evaluated by comparing the average importance and average inclusion ratings for the DS topics. No statistically significant difference was found in the inclusion ratings between early respondents ($M = 2.37$, $SD = 0.62$) and late respondents ($M = 2.33$, $SD = 0.47$) ($t(60) = 0.335$, $p > .05$). The results of the independent samples t-test comparing importance ratings between early responders ($M = 2.70$, $SD = 0.64$) and late responders ($M = 2.70$, $SD = 0.43$) found no statistical difference between groups ($t(60) = 0.030$, $p > .05$). Based on these findings, it can be concluded that the late responders, and hence the nonresponders, are not significantly different from the early responders. It can further be concluded that nonresponse error does not preclude one from generalizing the sample results to the population.

Statistical Description of Survey Respondents

The instrument used in this survey was sent by email to a random sample of agribusiness faculty members at US institutions that have four-year agribusiness degree-granting programs. A descriptive statistical analysis of the demographic factors reported by the responding faculty members follows. Faculty members were asked to report on the degree that DS topics are included in courses they teach, as well as various details about their own education and academic careers. Additionally, they reported certain characteristics about the agribusiness degree program at their university. See Appendix C for the questions used on the instrument. The respondents' years of teaching in higher education, by faculty rank are cataloged in Table 4. The majority of the responding faculty members held the rank of Professor (n = 137, 49.3%), and had been teaching in higher education for at least 13 years (n = 174, 62.6%).

Table 4

Respondents by Professorial Rank and Years Teaching in Higher Education (N = 278)

	0 to 3 Years	4 to 6 Years	7 to 9 Years	10 to 12 Years	13 Years or More	NR[a]	Total
Professor	1	0	0	4	130	2	137
Associate Professor	0	0	13	17	28	0	58
Assistant Professor	22	15	5	1	3	0	46
Lecturer, Instructor, Adjunct, etc.	6	3	4	3	11	0	27
Did not report rank	1	0	0	0	2	7	10
Total	30	18	22	25	174	9	278

[a]Years teaching not reported.

Frequencies and percentages relating to the reported amounts that DS topics occupy in the faculty member's coursework, by whether or not the faculty member self-reported teaching a DS course in the curriculum are shown in Table 5. Interestingly, one faculty member reported teaching a dedicated DS course, but that the course had no DS topics included in the lessons. Additionally, two faculty members reported that in the dedicated DS course that each taught, no more than 25% of the course topics were related to DS.

Table 5

Self-Reported Levels of Decision Science (DS) Topic Penetration in Courses Taught By Responding Faculty Members, by Whether They Teach a Dedicated DS Course

	Faculty member teaches a dedicated DS course (N = 157)			
	Yes (n = 46)		No (n = 111)	
	f	%	*f*	%
Primary course taught:				
No DS coverage	1	2.2	11	9.9
Slight DS coverage (up to 25% of course topics)	2	4.3	48	43.2
Major DS coverage (25% to 75% of course topics)	24	52.2	35	31.5
Substantial DS coverage (more than 75% of course topics)	19	41.3	6	5.4
Do not teach undergraduate courses	0	0.0	11	9.9
Secondary course taught:				
No DS coverage	3	6.5	23	20.7
Slight DS coverage (up to 25% of course topics)	22	47.8	46	41.4
Major DS coverage (25% to 75% of course topics)	16	34.8	12	10.8
Substantial DS coverage (more than 75% of course topics)	3	6.5	0	0.0
Do not teach another undergraduate course	2	4.3	30	27.0

Note. Of 278 faculty members responding, 157 reported on teaching a dedicated course in Decision Science. *Primary course taught* is the course that a responding faculty member teaches that contains the most inclusion of DS topics. *Secondary course taught* is the course that has the next most DS topic inclusion.

One hundred fifty-seven of the respondents answered the question about whether they taught a dedicated decision science course, with 29% responding affirmatively. However, even those who did not teach a dedicated course included DS material in the courses they did teach. Forty-three percent of those taught some, but less than 25% of the course content was related to DS topics. Only 9.9% of those not teaching dedicated

DS courses did not include any DS material in their curriculum. This indicates that faculty members, as designers of individual course curricula, seem to place value on the teaching of the topics.

Research Hypothesis 1 stated that respondents who teach DS topics will place more importance on the teaching of such subjects than those who do not. For this test, the dependent variable is continuous, being the calculated mean importance rating for all of the DS topics that a given respondent rated. The independent variable is an ordinal variable identifying the level of DS topic inclusion for that faculty member in his or her course that includes the most exposure of decision science concepts. The appropriate statistical test for this data is a Spearman's rho correlation test. For the topic inclusion variable, the response aligning with "I don't teach any undergraduate courses" was stripped from the variable response set (converted to "System Missing" in SPSS) so that only the ordinal responses from No to Substantial topic inclusion would be analyzed. The result of the test showed that the two variables were significantly positively correlated (Spearman's $\rho = .019$, $N = 251$, $p < .05$, two-tailed). Based on this result, we can reject Null Hypothesis 1 that there was no significant difference between respondents' perceptions of the importance of DS topics in the agribusiness curriculum relative to experience in teaching DS topics. The data provided evidence that teaching DS topics was positively correlated with the level of perceived importance of the topics in the curriculum.

In Table 6, faculty members' university degree types earned are reported against their professorial rank. The majority of faculty members hold degrees in agricultural economics, and only 11.2% of respondents hold a business degree.

Table 6

Faculty Academic Experience: Degrees Earned by Professorial Rank and Field

	Professor (*n* = 137)		Associate Professor (*n* = 58)		Assistant Professor (*n* = 46)		Lecturer, Adjunct, etc. (*n* = 27)		Total (*N* = 268)	
Degree Type	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%
Undergraduate:										
Econ/AgEcon	54	40.0	29	50.0	16	34.8	6	23.1	105	39.6
Other	50	36.3	18	31.0	17	37.0	11	38.5	94	35.5
Agribusiness	25	18.5	8	13.8	8	17.4	6	23.1	47	17.7
Business	7	4.4	2	3.4	5	10.9	4	15.4	17	6.4
None or NR	1	0.7	1	1.7	0	0.0	0	0.0	2	0.8
Masters:										
Econ/AgEcon	94	69.6	39	67.2	28	62.2	11	40.7	172	65.9
Other	17	12.6	7	12.1	10	22.2	7	25.9	41	15.5
Business	7	4.4	4	6.9	3	6.7	5	18.5	19	6.8
None or NR	15	10.4	4	6.9	3	4.4	0	0.0	22	7.5
Agribusiness	4	3.0	4	6.9	2	4.4	4	14.4	14	5.3
Doctoral:										
Econ/AgEcon	115	85.8	45	77.6	38	84.4	9	36.0	207	79.0
Other	13	9.0	6	10.3	6	11.1	6	24.0	31	11.1
Business	2	1.5	2	3.4	2	4.4	2	8.0	8	3.1
Agribusiness	2	1.5	1	1.7	0	0.0	0	0.0	3	1.1
None or NR	5	2.2	4	6.9	0	0.0	10	32.0	19	5.7
At least one Agribusiness or Business degree:										
Agribusiness	31	22.6	13	22.4	10	21.7	10	37.0	64	23.9
Business	11	8.0	6	10.3	6	13.0	7	25.9	30	11.2

Note. Only includes responses with professorial rank indicated (268 of 278 respondents).

Findings Related to Objective One

Objective 1 sought to describe how DS topics are included in the agribusiness curricula. Technical course content such as decision science can be included in a curriculum in various ways. Topics may be taught in a dedicated course on the subject or included as secondary or supporting subject matter within other coursework. Questions on the instrument were included to measure these factors. Respondents were asked not to consider a standard statistics course as a dedicated DS course, unless such course was specifically designed for teaching management decision making, rather than statistical concepts or techniques. Of the 278 faculty members, 276 answered the question on whether a dedicated DS course was included in their curriculum. Of those reporting, 155 (56.2%) stated that their curriculum did include a dedicated DS course. For those dedicated courses in curricula, the course may be either required or elective for majors, and also for minors. In Table 7, the distribution of responding faculty members by whether the dedicated courses were required for either majors or minors is shown.

Table 7

Dedicated Decision Science Courses, by Whether They Are Required for Agribusiness Majors and Minors, as Reported by Agribusiness Faculty Members

	Required		Elective	
	f	%	*f*	%
Agribusiness Majors (*N* = 162)	128	79.0	34	21.0
Agribusiness Minors (*N* = 151)	28	18.5	123	81.5

Additionally, a DS course may be taught in the department granting the agribusiness degree, or a course in another department such as a math or statistics department, or perhaps in the college of business, may be used to fulfill the requirement. In Table 8, the departments that are reported as teaching the dedicated DS course are shown.

Table 8

Dedicated Decision Science Courses by the Department Teaching the Course (N = 155)

Categories	*f*	%
Taught in the Respondent's Department	138	89.0
Taught in a College of Business Department	13	8.4
Taught in Another Department (Statistics, Math, or Economics)	3	1.9
Taught in Another College of Agriculture Department	1	0.6

Research Hypothesis 2 posited that respondents from departments that teach DS courses, rather than having another department teach them, will place more importance on the teaching of such subjects. An independent samples *t*-test was used to test the hypothesis. This test is employed to compare the means of an interval or ratio-level dependent variable for two independent classifications of an independent variable. In this case, the dependent variable was the mean of the importance ranking that each faculty member submitted for the DS topics, and the independent variable was a binary variable indicating whether that faculty member's department taught the curriculum's primary DS course.

Normality of the dependent variable must be assumed, but the test is fairly robust to small departures from normality (SPSS Inc, 2007). A Q-Q plot was performed in SPSS as a visual check on normality; Figure 3 shows the resultant graph. The graph does not indicate that normality should affect the interpretation of the *t*-test results. Further, a One-sample Komolgorov-Smirnov test procedure was used to check the goodness of fit to a normal distribution. For this test, the null hypothesis was that the mean importance ranking data were drawn from a population that was normally distributed. This statistical test showed that we could not reject the null hypothesis (K-S $Z = 1.011$, $N = 271$, $p = .259$), and may reasonably assume that the sample was drawn from a normally distributed population.

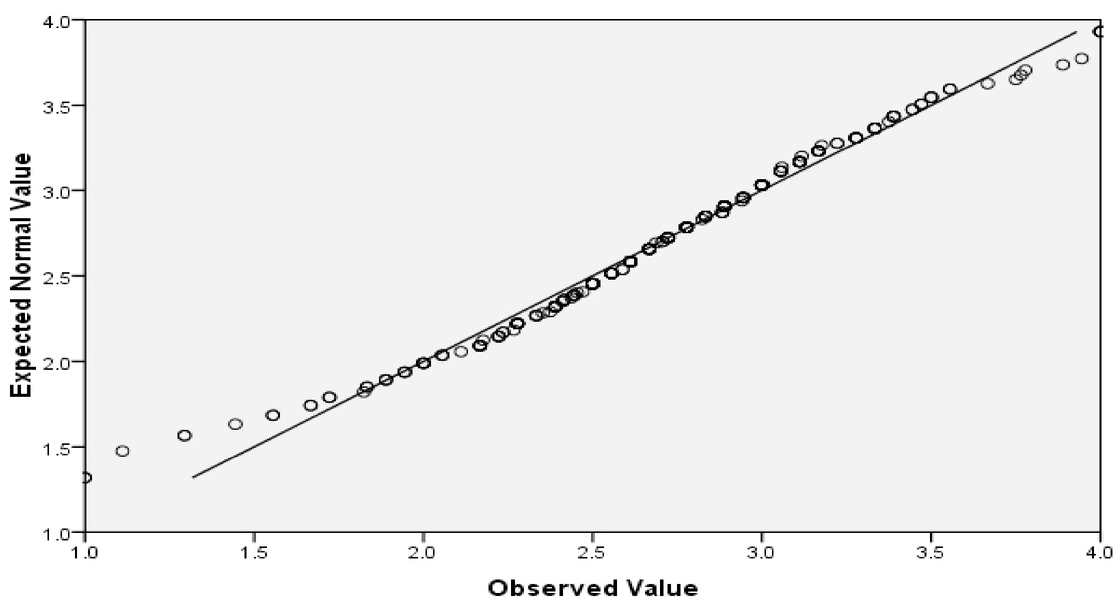

Figure 3. Normal Q-Q plot of mean of the importance score. Indicates that it can be reasonably assumed that the sample data for mean importance scores came from a normally distributed population.

Levine's test was used to test for equality of the sample variances. The test resulted in an *F* statistic of 4.826, and a significance level of .030, rejecting the null hypothesis that the samples came from populations with the same variance. As a result, the test results must be interpreted using the statistics that do not assume equal variance. Results of the independent samples *t*-test for the equality of means showed that we could not reject Null Hypothesis 2 that there was no difference in the mean importance rankings whether the course is taught within the department or not ($t = 0.498$, df = 21.6, $p = .624$).

Findings Related to Objective Two

The second objective of this study was to evaluate the perceived importance of the DS topics with respect to faculty and department characteristics, and develop a rank order of level of perceived importance. Respondents were asked to indicate the degree of importance that they believed each topic had with respect to inclusion in a four year undergraduate agribusiness curriculum, using 4-point Likert-type items. The ordinal scale allowed them to rate each topic as (1) Not Important, (2) Somewhat Important, (3) Important, and (4) Extremely Important. The overall importance ranking for each of the 18 DS topics in descending order of perceived importance, the number of valid responses, and the mean and standard deviations of the importance scale ratings, are reported in Table 9.

Additionally, the three scale items measured by the 18 DS topics were ranked (Table 10), with mean and standard deviations of the Likert-type scales. A summation of the items comprising the topic areas would not yield comparable data, as the scale items were made up of differing numbers of Likert-type items. As such, ranks were developed using scale means.

Table 9

Rankings of 18 Selected Decision Science Topics Based on Perceived Importance

Rank	Decision Science Topic	*f*	*M*	*SD*
1	Descriptive Statistics	269	1.61	0.72
2	Regression Analysis	270	1.36	0.78
3	Expected Monetary Value	264	1.24	0.83
4	Inferential Statistics	261	1.13	0.82
5	Probability and Distributions	269	1.12	0.78
6	Forecasting	267	1.09	0.79
7	Project Management	265	0.90	0.86
8	*Z*-Scores	259	0.89	0.86
9	Linear Programming	266	0.87	0.91
10	Decision Trees	263	0.85	0.84
11	Inventory Management	263	0.84	0.84
12	Simulation	262	0.82	0.86
13	Decision Tables and Rules	258	0.80	0.86
14	Total Quality Management	263	0.80	0.85
15	Game Theory	261	0.78	0.89
16	Material Resource Planning	262	0.69	0.80
17	Statistical Process Control	259	0.54	0.81
18	Analytic Hierarchy Process	257	0.21	0.77

Note. Frequency indicates number of 278 respondents who rated topic importance. Scale: 1 = Not Important, 2 = Somewhat Important, 3 = Important, 4 = Extremely Important.

Table 10

Rankings of Three Decision Science Topic Areas Based on Perceived Importance

Rank	Decision Science Topic Area	*N*	*M*	*SD*
1	Statistical Methods	271	2.93	0.59
2	Business Applications	270	2.62	0.62
3	Optimization	268	2.55	0.59

Note. Scale: 1 = Not Important, 2 = Somewhat Important, 3 = Important, 4 = Extremely Important.

Bivariate analyses (Pearson product-moment correlation tests) were used to determine if significant differences existed among mean importance scores for each topic area. A correlation coefficient is a statistical measure of relationship between two variables. Pearson's *r* describes the relationship between two continuous or, at a minimum, interval level variables (Gall et al., 2007). Each correlation coefficient was interpreted using the guidelines provided by Davis (1971) (Table 11).

Table 11

Davis' (1971) Descriptors for Relationship Strengths

Descriptor	Correlation Coefficient
Very strong	$1.00 \geq r \geq .70$
Substantial	$.50 \geq r \geq .69$
Moderate	$.30 \geq r \geq .49$
Low	$.10 \geq r \geq .29$
Negligible	$.01 \geq r \geq .09$

According to Davis' descriptors, a very strong positive relationship existed between the Statistical Methods topic area and the Optimization area, and substantial positive relationships existed among each of the other variables (Table 12). This result indicates that faculty members who ranked one topic area as high in importance tended to rank the other areas as high also, and vice versa.

Table 12

Pearson's r Correlations for Perceived Importance Rankings of Three Decision Science Topic Areas

Decision Science Topic Area	Business Applications	Optimization
Statistical Methods	.579* Substantial	.714* Very Strong
Business Applications		.599* Substantial

*p < .05 (2-tailed).

The mean importance measures for the three DS topic areas indicate that statistical methods were perceived to be more important than the other two areas. To test this inference, a Wilcoxon Signed Ranks Test was performed on each pair. In Table 13 the outcome of these analyses is shown. Based on the results of the tests, it can be concluded that the importance rankings for each of the DS topic areas differ significantly from the others.

Table 13

Wilcoxon Signed Rank Test for Differences in Perceived Importance Rankings of Three Decision Science Topic Areas

	Business Applications	Optimization
Statistical Methods	8.638*	9.978*
Business Applications		2.084 *

* p < .05.

Research Hypothesis 3 stated that respondents with at least one earned degree from a college of business will place more importance on the teaching of DS topics. It is possible that other variables could also be correlated, and lead to misinterpretation of the hypothesis test results. Two related factors that could lead to such misinterpretation are whether Professorial Rank is correlated with whether or not a business degree was earned, and whether Years of Teaching is correlated. To test for the presence of these confounding variables that may affect the interpretation of the Hypothesis 3 results, two tests were conducted in advance.

First, a nonparametric Kruskal-Wallis test was employed to determine if there was a significant difference between the observed proportions of business degree recipients and the expected level under the null hypothesis of equal proportions. The Kruskal-Wallis test is used when the data include one independent categorical variable with two or more levels, and an ordinal dependent variable. It is a non-parametric equivalent of the ANOVA analysis, not requiring the dependent variable to be normally distributed. It also can be considered similar to the Mann-Whitney *U* test, but allowing for more than two levels in the grouping variable. For this analysis, no assumption of normality could be made, and the Professorial Rank grouping variable had four levels. The results of this Kruskal-Wallis test are shown in Table 14. These results indicates that there was a not a significant difference in the proportion of faculty members that had earned business degrees, as a function of their professorial rank, using a 95% confidence limit.

Table 14

Kruskal-Wallis Test for the Presence of Business Degrees Earned, by Professorial Rank

Professorial Rank	*N*	K-W Mean Rank
Professor	137	130.26
Associate Professor	58	133.36
Assistant Professor	46	136.98
Lecturer	27	154.24

Note. Chi-Square test value = 7.447 with 3 df, p = .059. The K-W Mean Rank is a function of the Kruskal-Wallis test procedure, and is not comparable to the Professorial Rank.

Second, an equivalent Kruskal-Wallis test was performed to determine whether the presence of an earned business degree was correlated with the number of years that the faculty member had been teaching at an institution of higher learning. The results are shown in Table 15. The resultant asymptotic significance of .438 indicates that there was no significant difference in the presence of business degrees earned as a factor of years of teaching at an institution of higher learning.

Table 15

Kruskal-Wallis Test for the Presence of Business Degrees Earned, by Years of Teaching

Years of Teaching	*n*	K-W Mean Rank
13 Years or More	174	132.37
0 to 3 Years	30	133.45
10 to 12 Years	25	146.90
7 to 9 Years	22	144.45
4 to 6 Years	18	134.94

Note. Chi-Square = 3.771 with 4 df, p = .438; *N* = 267

These results allow Research Hypothesis 3 to be tested with less concern for whether the importance of teaching DS topics was related to the professorial rank of the respondent, and how long that faculty member had been teaching. There was no evidence that either of these factors was significantly related to whether a faculty member had earned a business degree. Had either of these tests shown significant results, it is possible that some of the variation in importance could be explained by rank or years of teaching.

An independent samples *t*-test was used to test Research Hypothesis 3. This test is employed to compare the means of an interval or ratio-level dependent variable for two independent classifications of an independent variable. In this case, the dependent variable was the mean of the importance ranking that each faculty member submitted for the DS topics, and the independent variable was a binary variable indicating whether that faculty member had earned a business degree.

Levine's test was used to test for equality of the sample variances. The test resulted in an F score of 0.960, and a significance level of .328, failing to reject the hypothesis that the samples came from populations with the same variances. Based on the independent samples *t*-test for the equality of means, we could not reject the null hypothesis that the mean importance rankings were the same whether a faculty member had earned a business degree or not ($\mu_0 - \mu_1 = -0.140$, $t = -1.335$, df = 263, $p = .183$). This finding will be discussed in Chapter V.

Research Hypothesis 4 stated that respondents from departments that have an industry advisory council will place more importance on the teaching of DS topics. An independent samples *t*-test was used to test this hypothesis. For this comparison, the dependent variable was the mean of the importance rankings that each faculty member submitted for the DS topics, and the independent variable was a binary variable indicating whether that faculty member's academic department had an industry advisory council. Of the 265 faculty members reporting on the industry advisory council, 100 (37.7%) indicated that their department did have such a council.

Levine's test failed to reject the null hypothesis that the samples came from populations with the same variances ($F = 2.640$, $p = .105$). The independent samples *t*-test for the equality of means showed that we could not reject the null hypothesis that the mean importance rankings were the same whether a faculty member's department had an industry advisory council or not ($t = -0.851$, $df = 263$, $p = .396$). We can reasonably conclude that the presence of an industry advisory council had no significant effect on faculty members' perceptions of the importance of DS topics in agribusiness curricula.

Findings Related to Objective Three

Every agricultural business degree program surveyed offered coursework in quantitative analysis and decision science topics. However, no guidelines exist through accreditation bodies that specify in what manner, or to what depth, such topics should be included in any given program. Objective 3 was to evaluate the respondents' perceived inclusion of the 18 identified DS topics with respect to faculty and department characteristics, and develop a rank order of level of perceived inclusion. The 18 DS topics are listed in Table 16 in order of perceived level of inclusion, based on the respondents' rankings on a four-point Likert-type scale.

Further, inclusion measures were determined for the three DS topic areas. The mean rankings of each area, along with standard deviations, are shown in Table 17 in a manner equivalent to that of the importance rankings in Table 10. The results of the Pearson product-moment correlation tests along with Davis' (1971) descriptors of the relationship strengths are then shown in Table 18.

Table 16

Rankings of 18 Selected Decision Science Topics Based on Perceived Inclusion in the Curriculum

Rank	Decision Science Topic	*f*	*M*	*SD*
1	Descriptive Statistics	261	3.10	0.78
2	Regression Analysis	262	2.91	0.89
3	Probability and Distributions	262	2.84	0.84
4	Expected Monetary Value	252	2.79	0.94
5	Inferential Statistics	256	2.73	0.94
6	*Z*-Scores	249	2.59	0.97
7	Forecasting	260	2.54	0.96
8	Linear Programming	258	2.29	1.06
9	Project Management	257	2.21	0.97
10	Decision Trees	255	2.18	0.93
11	Decision Tables and Rules	250	2.16	0.96
12	Inventory Management	256	2.15	0.96
13	Simulation	255	2.05	0.99
14	Total Quality Management	253	1.97	0.92
15	Game Theory	255	1.96	0.93
16	Material Resource Planning	250	1.90	0.92
17	Statistical Process Control	250	1.82	0.86
18	Analytic Hierarchy Process	248	1.57	0.78

Note. Frequencies of 278 respondents who rated the inclusion of the topic.
Scale: 1 = Not Included, 2 = Inadequately Included, 3 = Adequately Included, 4 = Very Much Included.

Table 17

Rankings of Three Decision Science Topic Areas Based on Perceived Inclusion

Rank	Decision Science Topic Area	*N*	*M*	*SD*
1	Statistical Methods	263	2.68	0.66
2	Business Applications	262	2.17	0.71
3	Optimization	261	2.15	0.69

Note. Scale: 1 = Not Included, 2 = Inadequately Included, 3 = Adequately Included, 4 = Very Much Included.

Table 18

Pearson's r Correlations for Perceived Inclusion Rankings of Three Decision Science Topic Areas

Decision Science Topic Area	Business Applications	Optimization
Statistical Methods	.512* Substantial	.580* Substantial
Business Applications		.757* Very Strong

*p < .05 (2-tailed).

The mean inclusion measures for the three DS topic areas indicate that statistical methods topics were included in agribusiness coursework more frequently than the other two areas. To test this inference, a Wilcoxon Signed Ranks Test was performed on each pair. Based on the results of the tests (Table 19), it can be concluded that the inclusion rankings for the Statistical Methods area differed significantly from the other two areas, but the rankings for Business Applications and Optimization did not differ significantly.

Table 19

Wilcoxon Signed Ranks for Differences in Perceived Inclusion Rankings of Three Decision Science Topic Areas

	Business Applications	Optimization
Statistical Methods	-10.067*	-10.991*
Business Applications		-0.775

* p < .05.

Findings Related to Objective Four

The fourth objective of this research project was to develop a rank order of teaching priority of the 18 identified DS topics using the Borich MWDS. Mean Weighted Discrepancy Scores are calculated from the raw data through the following process. To determine where discrepancies exist for the inclusion and importance of DS topics, a signed discrepancy score is determined for each respondent by subtracting the inclusion rating for each of the 18 DS topics from the importance rating. A weighted discrepancy score is then calculated by multiplying each discrepancy score by the mean of the associated importance rating. The MWDS is produced by taking the sum of the weighted discrepancy scores for each competency and dividing it by the number of respondents that ranked both the importance and inclusion for that topic (McKim & Pope, 2010). The process yielded the results found in Table 20, which are sorted from largest to smallest MWDS.

For the data in the present study, the weighted discrepancy scores could theoretically range from -12 to +12. The actual range was from -9.13 to +10.09. The MWDSs, which also had a theoretical range from -12 to +12, actually ranged from 0.22

to 1.68 (Table 20). These results do not imply that a topic with a low MWDS is unimportant. Topics already substantially included in the curricula will have a low discrepancy, and hence will show low perceived need to be added to the curriculum, whether they are perceived as important or not.

Table 20

Rankings Based on Perceived Need as Measured by Mean Weighted Discrepancy Scores for 18 Selected Decision Science Topics

Need	Decision Science Topic	Valid Pairs	MWDS
1	Project Management	253	1.68
2	Simulation	249	1.43
3	Forecasting	256	1.29
4	Inventory Management	250	1.19
5	Total Quality Management	249	1.18
6	Decision Trees	251	1.14
7	Linear Programming	255	0.94
8	Inferential Statistics	249	0.93
9	Statistical Process Control	245	0.92
10	Game Theory	250	0.89
11	Decision Tables and Rules	244	0.89
12	Analytic Hierarchy Process	243	0.87
13	Material Resource Planning	247	0.85
14	Descriptive Statistics	257	0.84
15	Expected Monetary Value	248	0.84
16	Regression Analysis	259	0.72
17	Probability and Distributions	259	0.56
18	*Z*-Scores	244	0.22

Note. MWDS measures the perceived need for a topic to be added to the curriculum. *Valid Pairs* indicates how many of the 278 respondents rated both the inclusion and the importance of the topic. Data that did not include both items in the pair were not used in the MWDS calculations. Low MWDS does not imply low importance to the curriculum.

While no MWDS values were less than zero in this sample, negative values are in the domain for MWDS. A negative value would imply that the collective faculty believed there was an overall need to remove the topic from the curriculum. A MWDS of zero would indicate that the faculty members as a whole perceived that the topic should neither be added nor removed from the current curriculum. A one sample *t*-test was performed on each MWDS score to determine whether the values differed significantly from zero. All scores except one were significantly greater than zero with $p < .05$; the value for the Z-Score topic was not significantly different from zero ($t(243) = 1.748$, $p = .082$).

Findings Related to Objective Five

The forced-entry multiple regression procedure was employed to identify which independent variables (i.e., faculty and department characteristics) significantly contributed to an explanation of the variation of the perceived importance of DS topics by faculty members. This method allows for every independent variable to be entered into the multiple linear regression equation, if it showed significant correlation with the dependent variable. Any independent variable contributing to the explanation of variation in importance scores would be identified by having a significant *t*-value for the β coefficient. These would then be left in the model, and non-significant variables would be removed. With only the variables showing significance left in the new model, the regression procedure would be performed again.

The results of this second regression procedure then provide for an analysis of the impact of faculty and departmental characteristics that are correlated with perceived importance through the demonstrated increment in R^2. Note that to preclude incorrect interpretation of the effect of any particular independent variable, only the explanatory effect of the group of independent variables as a whole should be interpreted. Pedhazur (1982) warned that in non-experimental research (such as the present study),

> . . . the independent variables tend to be correlated, sometimes substantially. This makes it difficult, if not impossible, to untangle the effects of each variable. In addition, some of the variables may serve as proxies for the "true" variables–a situation that when overlooked may lead to useless or nonsensical conclusions. (p. 175)

The bivariate correlational analysis of data using Spearman's rank correlations for the dependent and independent variables is found in Appendix F. In that appendix, The shortened variable names with their descriptions are catalogued in Table 21. In Table 22 the Spearman's correlation coefficients for pairs of independent variables are shown. Table 23 contains the Spearman's correlation coefficients between independent and dependent variables.

Results of the correlational analysis were used in two manners. Independent variables that significantly correlated with dependent variables were included in the first regression procedure for that dependent variable. Independent variables which correlated significantly with other independent variables were noted, as they could confound the interpretation of the explanation of variation.

Twenty-seven of the 39 independent variables had significant correlations with at least one dependent variable. The binary variable measuring whether the respondent conducted research in the application of DS topics had the greatest number, having been correlated with ten dependent variables. Twelve independent variables showed no significant correlations with any dependent variables.

Of the 18 dependent variables, the Importance of Linear Programming had the highest number of significant correlations with independent variables, at 11. None of the dependent variables showed no significant correlations, although the Importance of Decision Tables variable was only significantly correlated with one independent variable. Additionally, two dependent variables showed significant correlations with only two independent variables each.

Interpretation of results can be confounded when interaction exists among variables. Of the 741 independent variable correlation pairs, 264 (35.6%) were significantly correlated at the .05 level. These intercorrelations make it difficult, if not impossible, to model relationships among the variables. Determining which independent variables are endogenous and which are exogenous (Pedhazur, 1982) to any given model ultimately becomes an exercise in futility, and may likely lead to spurious conclusions.

Table 24 (found in Appendix G) contains the results of the regression analyses. Shortened variable names are the same as those defined in Table 21 and used in Tables 22 and 23, in Appendix F. For each importance score variable (numbered 1 through 18 in the order they were found on the instrument) the independent variables (IVs) in the initial regression are listed, along with key statistical results of the regression.

Results of these 18 analyses of variation differed widely among the dependent variables. Two of the models (Linear Programming, 11 IVs; Material Resource Planning, 3 IVs) had final regression models with no significant variables. Two other models (Analytic Hierarchy Process, 3 IVs; Decision Tables and Rules, 1 IV) had all variables with significant beta parameters. The range of the quantity of significantly correlated variables (initial regressions) was from one to 11. However, few remained in the final models. The range of the quantity of variables in the follow-on regressions was from zero to four. As noted previously, correlations among the independent variables can confound the interpretation of variation partitioning. These sets of IVs must be taken as a whole, and no attempt to mete out individual effects on changes in variation should be made (Pedhazur, 1982).

The model that explained the most variation in the dependent variable, both for the initial model and the final model, was that of the Regression Analysis. However, the initial model used eight of the 39 IVs to explain 18.4% of the error, and the final model used five variables to explain 13.9%. Overall, while some variation was explained in nearly all of the models, measuring faculty and department characteristics does not appear to be an effective method for explaining variation in perceived importance of decision science topics in undergraduate agribusiness curricula.

Summary of Results

Teaching DS topics in a faculty member's coursework was significantly correlated with faculty members' overall perception of the importance of DS topics in the agribusiness curriculum, albeit at a low level (Davis, 1971) (Research Hypothesis 1 was supported).

Although most (89%) dedicated DS courses were taught in departments granting agribusiness degrees, no significant relationship existed between department and overall perceived importance of teaching DS topics (Research Hypothesis 2 was not supported).

With respect to perceived importance of the three DS topic areas (Statistical Methods, Business Applications, and Optimization in order of perceived importance), statistically significant positive correlations existed between each pair. Faculty members who ranked one topic area as high in importance tended to rank the other areas highly, and vice versa. The mean importance rankings of each DS topic area were significantly different from each other.

Faculty members who had earned a business degree did not rate DS topics as more important compared to those who had not earned a business degree (Research Hypothesis 3 was not supported). Faculty members from departments with industry advisory councils (37.7%) did not rate the overall importance of DS topics higher than those from departments without such councils (Research Hypothesis 4 was not supported). Of the 18 DS topics studied, Project Management was identified as the specific topic most needed to be added to agribusiness curricula.

A forced-entry multiple regression process was used to analyze the relationship among dependent and independent variables for the purpose of explaining variation. Of the eighteen importance-related dependent variables, two had no significant relationship with any independent variables. The remaining models explained at most 13.9% of the variations, and frequently much less. Overall, the measured faculty and department characteristics do not seem very useful in explaining variations in the perceived importance of decision science topics in undergraduate agribusiness curricula.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

This chapter presents a summarization of the research process, including the purpose of the study and the research objectives. Additionally, a brief discussion of the findings and implications for each of the five research objectives and how they relate back to the literature is included. Any additional results noted are then included. Finally, recommendations for potential follow-on research are made.

Purpose of the Study

This study had several purposes. First, the study sought to assess the importance and inclusion of 18 selected decision science (DS) topics (Table 1) in four-year degree-granting undergraduate agribusiness programs, as perceived by faculty members currently teaching in those programs. Additionally, this study attempted to rank such DS topics in terms of their need to be added to the curriculum. Finally, the study used the forced-entry multiple regression procedure to identify factors that explained observed differences in the variation of perceived importance of the DS topics.

Study Design Critique

This study employed a descriptive correlational design with survey methodology used for data collection. A four-part Internet-based, researcher-developed questionnaire was employed, as it allowed for a large amount of data to be collected in a short time (Ladner et al., 2002). However, all the variables collected on the survey questionnaire were categorical or at best ordinal in scale. Due to that data limitation, many statistical analyses were limited to less powerful nonparametric procedures. In retrospect, including dependent variables that were continuous or at least on an interval scale would have allowed for more options in statistical analysis.

The faculty member sampling sub-frame had three distinct parts, which served well in allowing for a large number of potential respondents to be reached. With the benefit of hindsight, it likely would have saved time without sacrificing any accuracy in the frame to have omitted the email request to department chairs for candidate names.

The design of this study did not allow for any causation to be evaluated. It would be very interesting and informative to understand the causes of changes in variables that are observed, but several limiting factors were present. It was not possible to determine a time order for any of the constructs measured in the study. One could assume that a given perception of the importance of some construct led to the agent effecting that valued change, but that would be erroneous, or at least not data-supported. It may well have been that the presence of the curricular condition led to the respondent's perception. No attempt to measure timing factors, nor to infer causality was made in this study. Additionally, no attempt was made to manipulate independent variables. This study was correlational research, not experimental research.

Objectives of the Study

Five objectives were identified as warranting study:

1. Describe how DS topics are included in the various curricula represented by the sample, as reported by faculty member respondents.

2. Evaluate the perceived importance of the DS topics and topic areas with respect to faculty and program characteristics, and develop a rank order of level of importance.
3. Evaluate the perceived inclusion of the DS topics and topic areas with respect to faculty and program characteristics, and develop a rank order of level of inclusion.
4. Develop a rank order of teaching priority of the 18 identified DS topics using Mean Weighted Discrepancy Scores (MWDS).
5. Determine the faculty and department characteristics that explain variations in the perceived importance of DS topics in the curricula.

Interpretation of Research Findings

In the end, the results of this research must relate back to its theoretical base. The base for this study is rooted in instructional design, and the process of how learning systems such as curricula are designed and built to achieve desired outcomes. Dick and Carey (1996) modeled such a system by dividing the process into ten explicit, ordered steps. Russell and Trede (1999) designed a similar process aimed specifically at an urban agricultural education program. The key to both, and the starting point for each, is needs assessment. Without a solid understanding of what a given program needs to have or do to create successful outcomes, any such attempt will likely suffer setback, and may eventually fail to produce the desired results. Russell and Trede (1999) recognized that such needs include those of the students, the agribusiness industry, and society in general. They proffered the idea of an industry council that would bring together relevant stakeholders to identify the needs of the curriculum.

A common method of identifying training needs is through the use of Borich's (1980) methodology. Through the Borich procedure, measures of "what should be" and "what is" are taken (McKim & Pope, 2010), and converted into a ranked listing of curricular needs. For the present study, the "what should be" was measured through the importance constructs, and the "what is" was measured through the inclusion constructs.

Using the MWDS methodology, the data on the constructs of importance and inclusion were used to develop a ranked listing of the 18 selected DS topics, in order of perceived need to be added to the curriculum. All 18 topics had positive scores, meaning that in aggregate none were believed to be included more than their importance would suggest. Additionally, all but one of the scores were significantly different from zero.

Curricula are not static, but tend to evolve by small changes rather than infrequent major reconstructions (Williams, 1987). Curriculum committees reviewing agribusiness curricula, then, would likely be more interested in identifying the most needful areas to analyze. As these areas are studied and improved, other needs and concerns would become paramount. In the area of decision science, the top three curricular needs identified were first, Project Management, then Simulation, and finally, Forecasting.

The first hypothesis tested in this study related to the emphasis that faculty members place in the courses that they design and teach. Blank (1987) discussed how faculty members have control over not only the material they present in their own courses, but also in the local curriculum as a whole, through their membership on curriculum committees and the influence that they exert. Blank asserted that faculty members would select topics that they believed were worth conveying to the students.

Thus, a key question for this study to answer was whether there was a relationship between faculty members' perceptions of the importance of DS topics and their propensity to include those topics in their own courses. The results of this study supported that finding, concluding that faculty members did teach DS topics in their courses in relation to the importance that they placed on the material. Interestingly, even faculty members who did not teach DS-specific courses included the material in their courses.

The second hypothesis is similar to the first. Curriculum planners that choose to have a dedicated DS course in the program of study can have those classes taught within the department, or select a similar course already being taught in another department in the university. Research Hypothesis 2 conjectured that faculty members from departments that teach the course "in house" would place more importance on DS topics overall. However, Null Hypothesis 2 was not rejected. The data do not indicate that the decision to teach the course within the agribusiness department was significantly related to faculty members' overall perception of importance of DS topics. It could be that agribusiness faculty members value DS topics, and therefore believe that quantitative or business departments can teach them as well or better than their own department.

As developed in the literature review, business programs have a history of developing curricula with input from an accrediting body such as the AACSB or the ACBSP (Buttermore, 2010). Additionally, industry needs have long had an influence on business curricula (Campbell et al., 2006). In those curricula, operations research and management science topics have been an important part of Bachelor of Business Administration degrees (Kao et al., 1997), and Masters of Business Administration programs of study (Daniel, 1998).

The third hypothesis attempted to capture this relationship by asking whether faculty members who have come through the business school process (those having earned business degrees) would place greater importance on the teaching of DS topics in the agribusiness curricula. Since the literature indicates that business schools have a long history of including DS in their curricula, and accrediting bodies have required or emphasized such knowledge, faculty members with business degrees presumably would have been more exposed to that emphasis than those who did not have such degrees. However, the data did not provide strong enough evidence to reject the null hypothesis that there was no difference in the mean importance ratings for faculty that at least one business degree, versus those who had not earned a business degree. This could be due to the strong quantitative emphasis that many agricultural economics degree programs have.

One factor that could have affected this outcome was the relatively small proportion of faculty members that had earned a business degree, having been only 10.6%. Although that group of faculty members had a higher mean importance level

(2.83 to 2.69), the difference was not enough to be statistically significant; therefore, the research hypothesis was not supported.

Russell and Trede (1999) supported the use of an advisory council to aid in curriculum design. Industry advisory councils consist of business representatives who typically volunteer their time and effort to help academic departments and curriculum committees with various types of support including "curriculum advice, industry training materials, in-service opportunities for faculty, a source of adjunct faculty, equipment donations, supplemental funding, student internships, placement opportunities, and recognition of program excellence" (Campbell et al., 2004). However, as McGarry Wolf and Schaffner (2000) discovered, curriculum committees are not obliged to follow the recommendations of an advisory council, and may prefer the recommendations of faculty members to those of the council.

Research Hypothesis 4 posited that respondents from departments that have an industry advisory council will place more importance on the teaching of DS topics. If industry councils are active and effective, they should have an impact on curricular decisions. The literature review revealed that many research studies have documented the desire on the part of employers of agribusiness graduates for quantitative and decision analysis skills in their hires (e.g., Wallace et al., 1994).

Blank (1987) found that faculty and alumni from industry were in general agreement as to areas of curricular need. However, his research indicated that the industry representatives stressed the need for decision making skills and quantitative analysis to a greater extent than did faculty members.

Research Hypothesis 4, however, was not supported by the data. No significant difference was noted between the mean importance ratings of faculty members from departments with advisory councils and those without such councils. As with business-trained faculty members, the direction of the difference in the means indicated that the supposition could be true, but there was not enough statistical significance to defend the assertion.

The literature review did not reveal any curricular studies that attempted to explain variation using regression methodology. Therefore, this part of the study was considered to be exploratory in nature. Nearly all of the analyses of the amount of variation in importance dependent variables explained by independent variable sets yielded statistically significant results. However, the true value in the analysis is that of practical significance. The amount of explained variation in each case was minimal (no more than 13.9% of total variation). To be useful to curriculum designers, variables should reasonably be able to measured or controlled to use the results as a check to see if their programs were similar to other agribusiness programs. Additionally, the amount of variation explained should be enough to warrant the expense and effort in collecting and comparing the data. It is unlikely that the variation explained in this study was of sufficient quantity to pass the "practical significance" test.

Additional Implications and Recommendations

Recommendations based on the statistical results are limited because only one of the research hypotheses was supported by the data. Curriculum committees need qualified, research-based, information to make decisions that will affect the lives and livelihoods of many future students. The literature review indicated that key stakeholder groups (faculty members, graduates in the work force, employers) value quantitative knowledge, skills, and abilities. However, the collected data did not support making substantial changes to degree programs in the area of decision science topics. Additional study is advised.

Recommendations for Additional Research

Based on the results of data analysis in this research study and the review of literature, recommendations for follow-on or related future research are made.

Agribusiness programs have highly integrated curricula that involve many fields, from production agriculture to marketing and finance. Curriculum committees have been shown to make content decisions based on observing what other similar programs teach, and the level of value that faculty members place on certain content in their field. This literature review did not identify studies that strongly linked the processes used by such committees to theoretical models of curriculum design. Research applying theoretical curriculum design models to agribusiness curriculum development processes would be insightful for future curriculum committees. Additionally, a replication study of this research project could be conducted in five to ten years to evaluate the changes in the state of DS topics in the curricula.

No research studies were found that analyzed the effect of the department which teaches a course in a given degree program. Many programs contain coursework and subject matter than can be taught within the major department, or outside it. For example, in graduate programs, many departments prefer to teach statistical methods courses using their own faculty, while others use a university service course taught in the statistics department. Departments of Agricultural Education may choose coursework from education departments for requirements. How do departments make these choices, and what are the effects? This area could be the subject of a research study.

Industry advisory councils have been proffered as a tool for aiding departments in aligning curricula with the needs of the businesses that will be hiring their graduates. Are they effective? Can their positive effects be gained through the use of guest speakers from industry? Correlational research should be conducted linking council makeup and charter with actual results, perhaps in the areas of graduate placement and starting salaries.

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APPENDIX A

IRB APPROVAL

TEXAS A&M UNIVERSITY
DIVISION OF RESEARCH AND GRADUATE STUDIES - OFFICE OF RESEARCH COMPLIANCE

1186 TAMU, General Services Complex	979.458.1467
College Station, TX 77843-1186	FAX 979.862.3176
750 Agronomy Road, #3500	http://researchcompliance.tamu.edu

Human Subjects Protection Program — Institutional Review Board

DATE: 20-May-2010

MEMORANDUM

TO: WOLFSKILL, LAWRENCE A
77843-3578

FROM: Office of Research Compliance
Institutional Review Board

SUBJECT: Initial Review

Protocol Number:	2010-0356
Title:	Dissertation: Perceptions of Decision Science in Agribusiness
Review Category:	Exempt from IRB Review

It has been determined that the referenced protocol application meets the criteria for exemption and no further review is required. However, any amendment or modification to the protocol must be reported to the IRB and reviewed before being implemented to ensure the protocol still meets the criteria for exemption.

This determination was based on the following Code of Federal Regulations:
(http://www.hhs.gov/ohrp/humansubjects/guidance/45cfr46.htm)

45 CFR 46.101(b)(2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior, unless: (a) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (b) any disclosure of the human subjects' responses outside the research

could reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, or reputation.

Provisions:

This electronic document provides notification of the review results by the Institutional Review Board.

APPENDIX B

CORRESPONDENCE

LETTER TO DEPARTMENT HEADS

Howdy Dr. [LASTNAME],

My name is Art Wolfskill, a doctoral student at Texas A&M University in the department of Agricultural Leadership, Education, and Communications. I need your help with my dissertation research. I am asking you to help me in two ways: identify which faculty members in your department would be best suited to provide their insights, and respond to the online questionnaire yourself.

My dissertation is investigating the integration of decision science principles and topics in four-year undergraduate agribusiness degree programs. The purpose of this study is to determine how faculty members and department heads perceive the penetration and importance of teaching these quantitative topics in the undergraduate curriculum.

For you and your faculty members, a link will be provided to a web-based questionnaire on your perspectives on decision science topics in your curriculum. The online survey will take approximately 15-20 minutes of your time. Participation in the study is voluntary and will remain confidential.

Here's how you can help me:
Please reply to this email with the names and email addresses of the faculty members in your department that teach undergraduate courses in the agribusiness degree field.

Thank you for your help in allowing me to identify the best faculty members for this research. Since I am sampling the population of agribusiness programs in the country, each respondent plays a critical role assuring that the results of this study are valid and generalizable. I do not know of a good, complete listing of agribusiness faculty members to use as a reliable sampling frame, so your help is crucial.

Any participant may withdraw from the study at any time. Receipt of your survey responses will serve as informed consent to participate in this study. No compensation will be offered for participation.

My study has been approved by my doctoral committee at Texas A&M University as of the Spring of 2010, and the Office of Research Compliance (IRB) at Texas A&M. Any questions about the rights of participants in the study can be addressed to:
Human Subjects' Protection Program Staff, MS 1186 TAMU, College Station, TX 77843
Phone: 979.458.4067 Fax: 979.862.3176 Email: irb@tamu.edu.
If you have any questions about the study, please email me at wolfskill@tamu.edu.

Thank you again for your valuable assistance.

Sincerely,
Art Wolfskill, Doctoral Candidate
Gary J. Wingenbach, PhD, Committee Chair
Texas A&M University

PRENOTICE

Howdy Dr. [LASTNAME]:

Have you taught agricultural business courses at [UNIVERSITY] or elsewhere, or led faculty members who do?

My name is Art Wolfskill, and as part of my dissertation research, I am surveying faculty members on the role that decision science topics play in their undergraduate program.

You've been randomly selected from a frame that included you because your department chair identified you to me as a good candidate for helping with the research, you self-selected Agribusiness as a topic of interest in the AAEA database, or your departmental website listed you as an agribusiness professor. I hope you will help me.

On Monday you'll get an e-mail (with a password and Web link) for a brief online survey about your opinions and perceptions of the role of decision science topics in the curriculum. It will take about 10 to 15 minutes to complete. It doesn't matter whether or not you actually teach those topics; in fact, I need a range of faculty members from all disciplines. The only requirement is that you have taught undergraduates, or are a department or section leader for a program that teaches undergraduates.

This study was approved by the Institutional Review Board—Human Subjects in Research, at Texas A&M University (#2010-0356). Full disclosure as required by IRB will be on the website. I'm sending this note today because some people like to know ahead of time that they will be contacted.

The study is important and it will be used to help faculty members and curriculum designers better understand the role that decision science topics have in agricultural business undergraduate programs. Your contribution is important, as a limited number of faculty members have been selected to participate. I'm sure you understand the importance that each member of a sample has to the reliability and validity of the research.

Thanks for your time, Dr. [LASTNAME]. It's only through your help that this research can be most successful. If you have any questions, feel free to email me.

Sincerely,

Art Wolfskill, PhD Student
Department of Agricultural Leadership, Education, and Communications
Texas A&M University
wolfskill@tamu.edu

INITIAL CONTACT: INVITATION TO PARTICIPATE

Dear Dr. [LASTNAME]:

Have you taught undergraduate agricultural business, either at [UNIVERSITY] or elsewhere? Or do you lead a department or program area? I believe that you fit that description, and you've been selected as part of the random sample to participate in a survey on Faculty Perceptions of Decision Science Topics in Undergraduate Agribusiness Programs. You don't have to teach quantitative subjects to participate.

I'd like to ask you to invest a few minutes of your time filling out a short questionnaire on your perceptions on a specific area of your program. You should have received a prenotice email with more information a few days ago.

This study was approved by the Institutional Review Board—Human Subjects in Research at Texas A&M University (#2010-0356).

The online survey is 4 short pages, and should take about 10 to 15 minutes to complete. If you need to stop and come back later, there is a link to save at the top of each page. There aren't any right or wrong answers in this survey; we just want your honest response to each question. When you're ready, please go to:

http://surveys.ag-communicators.org/Wolfskill/

Read the Information and Consent Form, and then enter your unique password, which is: XX999

Remember Dr. [LASTNAME], your input is extremely important to the successful completion of this research. Your views on the inclusion of decision science topics in the agribusiness curriculum will help other faculty members and curriculum designers better develop programs to produce successful agribusiness graduates.

If you are interested in the results of the study, please email me separately.

Sincerely,

Art Wolfskill, PhD Student
Department of Agricultural Leadership, Education, and Communications
Texas A&M University
wolfskill@tamu.edu

FIRST REMINDER NOTICE

Dear Dr. [LASTNAME]:

I recently sent you an email asking you to help me out with my dissertation research by responding to a short questionnaire on the agribusiness curriculum. Perhaps you missed the email, or have been busy. I understand completely. I'm sure you understand how important the response rate is for the validity and reliability of any research study. You may have started it and saved, but haven't gotten back to finish it. Will you take the time now and fill it out?

I need the perspective of faculty members like you, with a wide variety of experience in teaching. It doesn't matter if you are now teaching agribusiness courses, as long as you have taught one, or are a department or section leader of faculty members who have. Chairs have a unique perspective on the overall curriculum. It also doesn't matter if you are tenured, tenure track, a lecturer, adjunct, or a teaching graduate student.

I imagine that classes at [UNIVERSITY] are not in session now, so it would be a good time to invest a few minutes to complete the survey and help me out. The study has been approved by the Institutional Review Board—Human Subjects in Research at Texas A&M University (#2010-0356).

The online survey is 4 short pages, and should only take about 10 to 15 minutes to complete. If you need to stop and come back later, there is a link to save at the top of each page. There aren't any right or wrong answers in this survey; we just want your honest response to each question. When you're ready, please go to:

http://surveys.ag-communicators.org/Wolfskill/

Read the Information and Consent Form, and then enter your unique password (2 letters followed by 3 digits), which is: XX999

Remember Dr. [LASTNAME], your input is extremely important to the successful completion of this research. Your views on the agribusiness curriculum will help other faculty members and curriculum designers better develop programs to produce successful agribusiness graduates.

If you are interested in the results of the study, please email me separately.

Thank you for your help,

Art Wolfskill, PhD Student
Texas A&M University
wolfskill@tamu.edu

SECOND REMINDER NOTICE

Howdy Dr. [LASTNAME],

First things first. If you recently completed the short questionnaire for my dissertation study on the agribusiness curriculum, I want to both thank you and apologize. Thanks for completing it, and sorry that you are receiving this reminder. I have not received the most recent update from the database with the list of remaining non-responders. As part of the research design, I don't actually get the names of those who do respond.

Recall that you don't need to actually teach decision science topics to complete the survey. In fact, I need a variety of outlooks from within the agribusiness field. As long as your course is either required or elective for agribusiness students, you're important to the reliability and validity of this study. That includes Ag and Resource Economics, Marketing, Management, and so forth. Also, if you are a department or section leader for those who teach in the agribusiness program, I need you too. Your holistic view of the curriculum is important to capture.

If you haven't taken the time to complete the survey, this is a friendly reminder to log on using the link and your password which I have included below. You may need to hold down the CTRL key when you click the link to make it work.

http://surveys.ag-communicators.org/Wolfskill/ Your password is XX999 (two letters followed by three digits)

If you have had trouble logging in to the questionnaire, please let me know and I will email a Word version to you. Your response is that important.

Now would probably be a good time to invest a few minutes to complete the survey, as classes at [UNIVERSITY] probably haven't started yet. Again, the study has been approved by Texas A&M's IRB (#2010-0356). (I should probably say that any time I communicate with you.)

Remember Dr. [LASTNAME], your input is extremely important to the successful completion of this research.

Thanks for helping me,

Art Wolfskill, PhD Student
Texas A&M University
wolfskill@tamu.edu

THIRD REMINDER NOTICE

Howdy Dr. [LASTNAME],

This is my final email to you asking you to complete the short questionnaire for my dissertation study on the agribusiness curriculum. I would like to strongly encourage you to do one of two things for me:

If you have taught an agribusiness course or led those who have, please consider helping me with my dissertation research and lending your insight to the study. Your colleagues will appreciate it, as the results may help them make better curriculum decisions in the future.

If you believe that you are not qualified to complete it, please email me back and let me know. I won't beg you to fill it out, but I will be able to sanitize my sample to only include those who truly were in the frame. If you don't let me know, I have to assume you were a legitimate candidate for the study. Unfortunately, that will increase the non-response rate, and lessen the impact that the research may have. I'm sure you understand all that.

To help control for non-response, I will be contacting a select few of the non-responders to verify that the non-response group is not significantly different in any key areas from the responders. (Of course, if everybody responds or opts out at this point I won't have to do that...)

I do appreciate your patience with me, and I'm sure you remember the days leading up to your dissertation and defense. The data collection period will close soon, and your inbox will be at peace again – at least from me. Remember, though, that if you are interested in the results please let me know and I will get them out to you when ready. I won't even ask you to read the whole dissertation, although maybe I will entice you to with the results.

Below, one final time, is your individual login link and password.

http://surveys.ag-communicators.org/Wolfskill/ Your password is XX999 (two letters followed by three digits)

If your reason for not responding yet is that you prefer a Word document version, please let me know and I will email it to you, and include your responses in the data set when you send it back. As I've mentioned each time, the study has been approved by Texas A&M's IRB (#2010-0356).

Remember Dr. [LASTNAME], your input is important to the reliability of this research, and the ability of our discipline to generalize the results and use them to improve their programs.

Thanks for helping me,

Art Wolfskill, PhD Student
Texas A&M University
wolfskill@tamu.edu

NOTICE TO PARTICIPANTS WHO STARTED BUT DID NOT FINISH THE QUESTIONNAIRE

Howdy Dr. [LASTNAME],

I'll be brief. My database has flagged you as someone who started the questionnaire, but has not completed it. It could be that you meant to get back to it and didn't, or perhaps you decided that you did not qualify to complete it once you saw the questions.

Either is fine, but I need to close data collection, so I am asking that you please either log back in and complete your questionnaire, or send me a brief email telling me why you haven't finished, so I can correctly handle the instance. I know it involves some time and effort on your part, but I would be extremely grateful if you would help me out in this way.

Again, here is the link and your password.

http://surveys.ag-communicators.org/Wolfskill/ Your password is XX999 (two letters followed by three digits)

If your reason for not finishing is that you prefer a Word document version, please let me know and I will email it to you, and include your responses in the data set when you send it back. As I've mentioned each time, the study has been approved by Texas A&M's IRB (#2010-0356).

Thanks again for helping me,

Art Wolfskill, PhD Student
Texas A&M University
wolfskill@tamu.edu

NONRESPONSE ERROR MEASUREMENT REQUEST NOTICE

Howdy Dr. [LASTNAME],

I hope this is the final time I need to contact you about this. As with most questionnaires, participation is rarely, if ever, 100 percent. Part of good research involves determining whether there are any systematic differences between those who responded and those who chose not to respond. As a non-responder, I ask for your help in determining that.

I have attached a Word document with a small piece of the questionnaire, consisting of only a few of the original questions. Would you please fill it out, save it, and email it back to me? It is important to the reliability of the study that I measure whether the non-responding group is significantly different from the responders. It will just take two or three minutes, and will have a huge impact on the generalizability of my study.

I'm including your password so that you can reply to this email and the database will have record of the response. There is no website to go to, and you can view the entire sampling of the questionnaire on the attached Word document.

Your password is XX999 (two letters followed by three digits)

As I've mentioned each time, the study has been approved by Texas A&M's IRB (#2010-0356).

Thanks again for helping me,

Art Wolfskill, PhD Student
Texas A&M University
wolfskill@tamu.edu

APPENDIX C

SURVEY INSTRUMENT

Perceptions of Decision Science in Agribusiness Curricula

This instrument is designed to measure perceptions of the importance of decision science topics to the agribusiness curriculum. Your help in completing this research is greatly appreciated.

For the purposes of this questionnaire, the term decision science will be used to include all similar concepts (e.g. quantitative methods, operations research). Please consider these terms synonymous.

Do not consider a standard statistics course as a decision science course, unless it was specifically designed for teaching management decision making, rather than statistical concepts or techniques.

To what degree do you believe that general knowledge of Decision Science topics is important for a graduate of a bachelor-level undergraduate agribusiness program?

- Not important
- Somewhat important
- Important
- Extremely important

Does your agribusiness program include a Decision Science course?

- Yes
- No

If you answered YES, please answer the following questions about that course. If there is more than one Decision Science course, answer the questions based on a required course if there is one, or if none are required, the one that you are most familiar with.

For **majors**, the course is:	Required Elective
For **minors**, the course is:	Required Elective
Do you currently teach that course?	Yes No
Which department teaches that course?	My department Another department in the College of Agriculture Another department in the College of Business Other (please specify)

ALL respondents please continue from here
Which best describes the agricultural business degree awarded by your department?

- BS in Agricultural Business (Agribusiness, or similar)
- BS in Agricultural Economics with a specialization or minor in Agribusiness
- BS in Agriculture (General Ag, Interdisciplinary Ag., etc.) specializing in Agribusiness
- Other BS degree (please specify)
- Non-BS degree (BA or other, please specify)

Next Page ->
(Page 1 of 4 complete)

Perceptions of Decision Science in Agribusiness Curricula

If you need to stop, then Close the Survey **before answering any item on this page**.
You will be returned to this page the next time you login.

Directions:

For each of the decision science topics listed, please indicate the degree to which it is **included** in your agribusiness curriculum, and the degree to which you believe it is **important** to include in an agribusiness curriculum. Click the radio button in **each column**. All statements in this section use a 1 to 4 scale.

1 = Not included	Not important = **1**
2 = Inadequately included	Somewhat important = **2**
3 = Adequately included	Important = **3**
4 = Very Much included	Extremely Important = **4**

Inclusion 1	2	3	4	Course Topic	Importance 1	2	3	4
				Forecasting				
				Regression Analysis				
				Descriptive Statistics				
				Inferential Statistics				
				Probability and Distributions				
				Z-Scores				
				Linear Programming				
				Project Management				
				Inventory Management				
				Analytic Hierarchy Process				
				Simulation				
				Material Resource Planning				
				Total Quality Management				
				Decision Tables and Rules				
				Decision Trees				
				Expected Monetary Value				
				Game Theory				
				Statistical Process Control				

Inclusion 1	2	3	4	Type in two other topics not listed that you think should be included, and rate them on each scale	Importance 1	2	3	4

Next Page ->
(Page 2 of 4 complete)

Perceptions of Decision Science in Agribusiness Curricula

If you need to stop, then Close the Survey **before answering any item on this page**.
You will be returned to this page the next time you login.

Directions: Please select the **best** answer for each question by clicking the appropriate button. Consider the course you **currently teach** that contains the most decision science topic coverage.

To what degree do you include decision science topics in that course?

- No coverage
- Slight coverage (up to 25% of course topics)
- Major coverage (25 - 75% of course topics)
- Substantial coverage (more than 75% of course topics)
- I don't teach any undergraduate courses

To what degree do you include decision science topics in **other** undergraduate courses you teach?

- No coverage
- Slight coverage (up to 25% of course topics)
- Major coverage (25 - 75% of course topics)
- Substantial coverage (more than 75% of course topics)
- I don't teach any other undergraduate courses

Now please consider **all courses** currently included in the agribusiness degree program.

To what degree are decision science topics included in other undergraduate courses (not taught by you)?

- No coverage
- Slight coverage (up to 25% of course topics)
- Major coverage (25 - 75% of course topics)
- Substantial coverage (more than 75% of course topics)

Does your program have an industry advisory council or other industry group that has input into curriculum decisions?

- Yes
- No

From the following list, please choose the **top five** characteristics that prospective employers would desire for newly hired agribusiness college graduates, and **RANK** them according to your perception of their importance to the employers. Use a ranking scale of (**1** = most important, **2** = lesser importance, etc.) for your five choices.

- Interpersonal skills (e.g. leadership, management, teamwork)
- Problem solving, critical thinking, and analytical skills
- Communication skills (e.g. listening, presentation, professional writing)
- Technical competency in business fields (e.g. finance, production, marketing)
- Computer skills (e.g. office, light programming, Internet, database management)
- Prior work experience
- Prior internship experience
- International awareness
- International experience
- Foreign language skills

Next Page ->

(Page 3 of 4 complete)

Perceptions of Decision Science in Agribusiness Curricula

Please indicate your education degrees earned. Click one choice for each degree earned. If you have more than one in any category, choose the degree that most applies to your function of teaching undergraduate agribusiness courses.

Undergraduate:

- Agribusiness
- Economics or Agricultural Economics
- Business
- Other quantitative-type (statistics, etc.)
- Other agricultural - Please specify:
- Other type - Please specify:
- None

Masters:

- Agribusiness
- Economics or Agricultural Economics
- Business
- Other quantitative-type (statistics, etc.)
- Other agricultural - Please specify:
- Other type - Please specify:
- None

Doctorate:

- Agribusiness
- Economics or Agricultural Economics
- Business
- Other quantitative-type (statistics, etc.)
- Other agricultural - Please specify:
- Other type - Please specify:
- None

What is your professorial rank?

- Professor
- Associate professor
- Assistant professor
- Lecturer, Instructor, Adjunct, or similar

How many years have you been teaching at an institution of higher education?

- 0 to 3 years
- 4 to 6 years
- 7 to 9 years
- 10 to 12 years
- 13 years or more

How many years have you been teaching your current decision science course?

- 0 to 3 years
- 4 to 6 years
- 7 to 9 years
- 10 to 12 years
- 13 years or more

After your terminal degree, how much related work experience did you acquire outside of academia?

- 0 to 3 years
- 4 to 6 years
- 7 to 9 years
- 10 to 12 years
- 13 years or more

Are you a Department Head (or Chair)?

- Yes
- No

Does your research involve the application of decision science topics?

- Yes
- No

Does your research involve decision science topics beyond their application?

- Yes
- No

Continue ->

(Page 4 of 4 complete)

APPENDIX D

INFORMED CONSENT

Decision Science in Agribusiness Curricula

Information and Consent Page

Thank you for participating in this study, Decision Science in Agribusiness Curricula. The purpose of this study is to measure perceptions of the importance of decision science topics in undergraduate agribusiness curricula. This study involves faculty members from various universities, all who are over 18 years of age. The survey will take approximately **15 minutes** to complete. Do not add your name or other identifying data to the survey.

This research study has been reviewed by the Human Subjects' Protection Program and/or the Institutional Review Board at Texas A&M University. For research-related problems or questions regarding your rights as a research participant, you can contact these offices at (979) 458-4067 or e-mail at (irb@tamu.edu).

Please note the following characteristics of this study:

- your participation is voluntary;
- your identity will remain **anonymous**;
- the IP address of your computer will not be recorded;
- you can withdraw from this study at any time without penalty;
- there are no known risks or benefits from participating in this study;
- there is no compensation for participating in this study;
- the study will be used for research;
- the records of this study will be kept private; and
- data obtained from the study may be published in group format only.

By typing in the assigned password, the participant consents to participate in the study:
Enter your Password:
Confirm your Password:
Click the Login button Login Now!

If you want a copy of this Information and Consent Page, you can Print this Window

If you have questions about this site or research project, contact Art Wolfskill

APPENDIX E

NONRESPONDENT QUESTIONNAIRE

Type your password here: ________

Perceptions of Decision Science in Agribusiness Curricula Selected questions for Non-Response Analysis

This instrument is designed to measure perceptions of the importance of decision science topics to the agribusiness curriculum. Your help in completing this research is greatly appreciated.

For the purposes of this questionnaire, the term decision science will be used to include all similar concepts (e.g. quantitative methods, operations research). Please consider these terms synonymous.

Do not consider a standard statistics course as a decision science course, unless it was specifically designed for teaching management decision making, rather than statistical concepts or techniques.

1. To what degree do you believe that general knowledge of Decision Science topics is important for a graduate of a bachelor-level undergraduate agribusiness program?

- Not important
- Somewhat important
- Important
- Extremely important

2. Which best describes the agricultural business degree awarded by your department?

- BS in Agricultural Business (Agribusiness, or similar)
- BS in Agricultural Economics with a specialization or minor in Agribusiness
- BS in Agriculture (General Ag, Interdisciplinary Ag., etc.) specializing in Agribusiness
- Other BS degree (please specify) ________
- Non-BS degree (BA or other, please specify) ________

Directions:

3. For each of the decision science topics listed, please indicate the degree to which it is **included** in your agribusiness curriculum, and the degree to which you believe it is **important** to include in an agribusiness curriculum. Click the radio button in **each column**. All statements in this section use a 1 to 4 scale.

1 = Not included	Not important = **1**
2 = Inadequately included	Somewhat important = **2**
3 = Adequately included	Important = **3**
4 = Very Much included	Extremely Important = **4**

Inclusion				**Course Topic**	Importance			
1	2	3	4		1	2	3	4
○	○	●	○	Forecasting	○	○	○	○
○	○	○	○	Regression Analysis	○	○	○	○
○	○	○	○	Descriptive Statistics	○	○	○	○
●	○	○	○	Linear Programming	○	○	○	○

4. Please select the <u>**best**</u> answer for each question by clicking the appropriate button.
Consider the course you <u>**currently teach**</u> that contains the most decision science topic coverage.
To what degree do you include decision science topics in that course?

- ● No coverage
- ○ Slight coverage (up to 25% of course topics)
- ○ Major coverage (25 - 75% of course topics)
- ○ Substantial coverage (more than 75% of course topics)
- ○ I don't teach any undergraduate courses

5. What is your professorial rank?

- ○ Professor
- ○ Associate professor
- ○ Assistant professor
- ○ Lecturer, Instructor, Adjunct, or similar

APPENDIX F

BIVARIATE CORRELATION COEFFICIENTS OF DEPENDENT AND INDEPENDENT VARIABLES

This appendix show the Spearman's Rank Correlation Coefficients of the variables that were used for analysis of explained variation. Categorical variables have been divided into binary response variables. Variable names in the table are shortened versions; a list of descriptions is shown in Table 21. The correlations for independent to independent variables are shown in Table 22, and the independent to dependent variable correlations are in Table 23.

Table 21

Abbreviated Variable Names and their Descriptions

Abbreviation	Description	
Independent Variables		
HasDSCourse	The program has a DS course	
ReqMaj	The DS course is required for majors	
ReqMin	The DS course is required for minors	
IsTeacher	The respondent teaches the DS course	
DeptTchDSmy	The DS course is taught in the:	Respondent's department
DeptTchDSothag		Another Ag department
DeptTchDSbu		College of Business
DeptTchDSoth		Another department
DegNameAgb	The degree offered is:	Agribusiness
DegNameAgec		Agricultural Economics
DegNameGenAg		General Agriculture
DegNameBSoth		Another BS degree
DegNameBA		A BA degree
DSincl0	Amount of DS topic inclusion in the respondents coursework:	None
DSincl1		Slight
DSincl2		Major
DSincl3		Substantial
Council	The department has an Industry Advisory Council	
RankProf	The respondent's rank	Professor
RankAsoc		Associate Professor
RankAsst		Assistant Professor

Table 21 continued

Abbreviation	Description	
RankLect		Lecturer, Adjunct, etc.
YrsTch03	Years teaching higher educ.:	Zero to three
YrsTch46		Four to six
YrsTch79		Seven to nine
YrsTch1012		Ten to twelve
YrsTch13up		Thirteen and greater
YrsWork03	Years of non-educational work:	Zero to three
YrsWork46		Four to six
YrsWork79		Seven to nine
YrsWork1012		Ten to twelve
YrsWork13up		Thirteen and greater
Chair	Respondent is department chair	
ResAppl	Respondent's research involves the application of DS	
ResMore	Respondent's research involves DS topics beyond their application	
COBAUnd	Has business degree at the undergraduate level	
COBAMas	Has business degree at the masters level	
COBADoc	Has business degree at the doctoral level	
COBAnum	Number of business degrees earned	
Dependent Variables	Each measures the respondent's perception of the importance of:	
ImpFcst	Forecasting	
ImpRegr	Regression Analysis	
ImpDesc	Descriptive Statistics	
ImpInfer	Inferential Statistics	
ImpProb	Probability and Distributions	
ImpZscore	*Z*-Scores	
ImpLP	Linear Programming	
ImpPM	Project Management	
ImpInv	Inventory Management	
ImpAHP	Analytic Hierarchy Process	
ImpSim	Simulation	
ImpMRP	Material Resource Planning	
ImpTQM	Total Quality Management	
ImpDTab	Decision Tables and Rules	
ImpTrees	Decision Trees	
ImpEMV	Expected Monetary Value	
ImpGame	Game Theory	
ImpSPC	Statistical Process Control	

Table 22

Bivariate Correlation Coefficients between Independent Variable Pairs

Variable	Spearman's Rank Correlation Coefficients												
	HasDS Course	Req Maj	Req Min	Is Teacher	DeptTch DSmy	DeptTch DSothag	DeptTch DSbu	DeptTch DSoth	Deg Agb	Deg Agec	Deg GenAg	Deg BSoth	Deg BA
HasDS Course	1.000												
ReqMaj	.309*	1.000											
ReqMin	-.027	.216*	1.000										
IsTeacher	.013	.125	.075	1.000									
DeptTch DSmy	.303*	.128	.063	.236*	1.000								
DeptTch DSothag	.013	.041	.171*	-.050	-.210*	1.000							
DeptTch DSbu	-.223*	-.096	-.078	-.201*	-.851*	-.025	1.000						
DeptTch DSoth	-.231*	-.113	-.079	-.100	-.424*	-.013	-.051	1.000					
Deg Agb	-.015	-.098	-.133	.003	-.116	.065	.175*	-.114	1.000				
Deg Agec	.018	.112	.210*	-.127	.150	-.041	-.167*	.015	-.638*	1.000			
Deg GenAg	-.120*	-.045	.062	.100	-.121	-.022	.082	.115	-.399*	-.166*	1.000		
Deg BSoth	.148*	.082	-.110	.095	.075	-.028	-.115	.070	-.364*	-.152*	-.095	1.000	
Deg BA	-.050	-.156*	-.039	-.050	.030	-.006	-.026	-.013	-.130*	-.054	-.034	-.031	1.000

Table 22 continued

Variable	HasDS Course	Req Maj	Req Min	Is Teacher	DeptTch DSmy	DeptTch DSothag	DeptTch DSbu	DeptTch DSoth	Deg Agb	Deg Agec	Deg GenAg	Deg BSoth	Deg BA
	Spearman's Rank Correlation Coefficients												
DSincl0	-.166*	.026	-.081	-.133	-.178*	-.023	.151	.106	.085	-.102	-.003	.017	-.039
DSincl1	-.295*	-.063	.076	-.380*	.015	-.055	-.083	.150	.000	.044	.015	-.100	.049
DSincl2	.231*	.070	-.017	.194*	-.053	-.063	.146	-.127	-.030	-.027	.067	.017	.010
DSincl3	.259*	.003	.011	.447*	.109	.188*	-.138	-.069	.007	.019	-.064	.041	-.034
Council	.126*	-.025	-.137	.129	-.060	-.069	.073	.025	-.004	-.053	.061	.023	-.008
Rank Prof	.038	.052	.090	-.007	.025	.075	-.086	.071	-.012	-.021	.069	-.034	.033
Rank Asoc	-.105	-.127	-.043	.008	-.070	-.038	.131	-.076	.070	-.063	.013	-.057	.031
Rank Asst	.073	.092	-.081	-.059	-.007	-.039	.062	-.079	-.014	.086	-.084	.007	-.049
Rank Lect	-.012	-.045	.008	.080	.060	-.026	-.106	.085	-.057	.013	-.027	.125*	-.036
YrsTch 03	.069	.098	-.014	-.033	-.025	-.031	.005	.059	-.151*	.112	-.033	.152*	-.038
YrsTch 46	.022	.077	-.053	-.010	.031	-.022	-.005	-.045	.064	.048	-.086	-.081	-.029
YrsTch 79	.012	.095	.044	.082	.046	-.024	-.020	-.049	-.010	.049	-.003	-.040	-.032
YrsTch 1012	-.059	-.092	-.063	-.078	-.033	-.023	.069	-.047	.075	-.068	-.015	-.003	-.034

Table 22 continued

Variable	DSincl0	DSincl1	DSincl2	DSincl3	Council	Rank Prof	Rank Asoc	Rank Asst	Rank Lect	YrsTch 03	YrsTch 46	YrsTch 79	YrsTch 1012
DSincl0	1.000												
DSincl1	-.322*	1.000											
DSincl2	-.234*	-.564*	1.000										
DSincl3	-.121*	-.293*	-.212*	1.000									
Council	-.068	-.144*	.181*	.102	1.000								
Rank Prof	.075	-.054	-.029	-.019	-.059	1.000							
Rank Asoc	-.021	.066	.061	-.086	.032	-.537*	1.000						
Rank Asst	-.134*	.017	.034	.011	.004	-.466*	-.239*	1.000					
Rank Lect	.072	-.021	-.079	.135*	.049	-.342*	-.176*	-.152*	1.000				
YrsTch 03	-.058	-.005	-.042	.038	.045	-.331*	-.185*	.542*	.122*	1.000			
YrsTch 46	-.099	.002	.060	.009	-.074	-.273*	-.142*	.470*	.058	-.095	1.000		
YrsTch 79	-.068	-.046	.141*	-.010	.108	-.305*	.271*	.043	.080	-.106	-.080	1.000	
YrsTch 1012	-.079	.103	-.005	-.022	-.025	-.224*	.360*	-.113	.020	-.113	-.086	-.096	1.000

Table 22 continued

Variable	Spearman's Rank Correlation Coefficients												
	HasDS Course	Req Maj	Req Min	Is Teacher	DeptTch DSmy	DeptTch DSothag	DeptTch DSbu	DeptTch DSoth	Deg Agb	Deg Agec	Deg GenAg	Deg BSoth	Deg BA
YrsTch 13up	-.028	-.113	.045	.026	-.007	.060	-.028	.037	.026	-.086	.078	-.033	.079
YrsWork 03	.054	-.116	-.054	-.057	.095	-.142	-.068	-.002	-.011	.068	-.062	-.007	-.017
YrsWork 46	-.060	-.058	.032	-.101	-.081	.256*	-.026	.091	.023	-.002	-.019	-.003	-.034
YrsWork 79	-.001	.048	-.108	.109	-.172*	-.019	.220*	-.038	.087	-.077	.036	-.071	-.025
YrsWork 1012	-.012	.103	-.013	.020	.070	-.015	-.059	-.030	.052	-.058	-.005	.006	-.022
YrsWork 13up	-.013	.142	.165*	.101	.031	-.022	-.005	-.045	-.120	-.002	.098	.070	.105
Chair	-.080	-.050	.056	-.102	-.110	-.034	.048	.161*	-.056	-.027	.127*	-.017	.048
Res Appl	.235*	.067	-.049	.169*	.046	.046	-.064	-.001	-.054	.211*	-.228*	.035	-.001
Res More	.266*	-.052	.156	.105	.084	.097	-.093	-.052	-.149*	.173*	-.054	.068	.006
COBA Und	.007	.006	.036	-.050	.021	-.021	.004	-.042	.082	-.057	-.084	.038	-.028
COBA Mas	-.101	-.116	.075	.064	.080	-.017	-.068	-.035	.125*	-.100	-.088	.028	-.023
COBA Doc	-.025	-.114	-.056	-.105	-.058	-.013	.084	-.027	.004	-.089	.016	.111	-.015
COBA num	-.073	-.113	-.010	-.007	.049	-.025	-.022	-.050	.137*	-.119*	-.077	.029	-.037

Table 22 continued

Variable	Spearman's Rank Correlation Coefficients												
	DSinc l0	DSinc l1	DSinc l2	DSinc l3	Council	Rank Prof	Rank Asoc	Rank Asst	Rank Lect	YrsTch 03	YrsTch 46	YrsTch 79	YrsTch 1012
YrsTch 13up	.177*	-.034	-.081	-.011	-.039	.672*	-.181*	-.556*	-.168*	-.479*	-.362*	-.404*	-.433*
YrsWork 03	-.004	.033	-.010	-.083	-.086	-.042	.063	.135*	-.191*	.085	.091	-.071	-.015
YrsWork 46	-.074	.025	.048	.020	-.009	.096	-.039	-.109	.033	-.066	-.087	-.097	.117
YrsWork 79	.023	-.006	-.040	.088	.062	-.007	-.002	-.019	.039	-.076	.078	-.068	-.013
YrsWork 1012	-.014	-.109	.033	.055	-.004	-.025	-.018	.005	.063	-.007	-.056	.212*	-.067
YrsWork 13up	.079	.005	-.026	-.001	.104	-.009	-.047	-.093	.201*	-.001	-.077	.121*	-.043
Chair	-.100	.064	-.002	-.084	.088	.221*	-.068	-.153*	-.081	-.061	-.122*	-.099	-.042
Res Appl	-.283*	-.168*	.234*	.153*	.129*	-.013	-.017	.172*	-.173*	.122*	.029	.145*	-.076
Res More	-.179*	-.158*	.112	.129*	.006	-.046	.002	.117	-.076	.157*	.053	.052	-.042
COBA Und	.002	-.013	.002	.015	.102	-.082	-.064	.083	.121*	.007	.052	.033	.021
COBA Mas	-.048	.094	-.075	.009	.053	-.095	.002	-.002	.157*	-.096	-.013	.136*	.118
COBA Doc	-.064	.114	-.019	-.058	.048	-.093	.012	.037	.093	.008	-.048	-.052	.094
COBA num	-.024	.051	-.044	.033	.104	-.106	-.017	.030	.161*	-.018	.001	.068	.092

Table 22 continued

Variable	Spearman's Rank Correlation Coefficients												
	YrsTch 13up	YrsWork 03	YrsWork 46	YrsWork 79	YrsWork 1012	YrsWork 13up	Chair	Res Appl	Res More	COBA Und	COBA Mas	COBA Doc	COBA num
YrsTch 13up	1.000												
YrsWork 03	-.052	1.000											
YrsWork 46	.072	-.539*	1.000										
YrsWork 79	.055	-.395*	-.075	1.000									
YrsWork 1012	-.047	-.348*	-.066	-.049	1.000								
YrsWork 13up	-.002	-.478*	-.091	-.067	-.059	1.000							
Chair	.187*	-.076	.061	-.061	-.094	.186*	1.000						
Res Appl	-.131*	.041	.007	-.085	.065	-.054	-.154*	1.000					
Res More	-.136*	-.010	.045	-.006	-.011	-.020	-.142*	.445*	1.000				
COBA Und	-.064	-.020	.021	.007	-.054	.047	.008	-.027	.005	1.000			
COBA Mas	-.080	-.011	.015	.008	-.056	.036	-.002	-.116	-.007	.358*	1.000		
COBA Doc	-.008	-.095	.018	.155*	-.037	.036	.041	-.065	.026	.224*	.391*	1.000	
COBA num	-.084	-.034	.009	.030	-.073	.076	-.028	-.112	.007	.743*	.773*	.520*	1.000

* $p < .05$.

Table 23

Bivariate Correlation Coefficients between Dependent and Independent Variable Pairs

Variable	Spearman's Rank Correlation Coefficients												
	HasDS Course	Req Maj	Req Min	Is Teacher	DeptTch DSmy	DeptTch DSothag	DeptTch DSbu	DeptTch DSoth	Deg Agb	Deg Agec	Deg GenAg	Deg BSoth	Deg BA
ImpFcst	.225*	.141	-.074	-.033	-.010	.103	.027	-.082	.051	-.080	-.093	.128*	-.005
ImpRegr	.228*	.143	.047	-.050	.037	.085	-.086	.041	-.066	.102	-.172*	.178*	-.076
ImpDesc	.090	.022	.025	-.080	.077	.076	-.051	-.105	-.086	.105	-.116	.116	.010
ImpInfer	.112	.107	-.012	-.045	.042	-.024	-.022	-.035	.036	.028	-.201*	.114	-.010
ImpProb	.091	.065	-.032	-.113	.021	-.018	-.005	-.026	-.034	.077	-.168*	.125*	-.008
ImpZscore	.037	.113	-.013	.044	.021	.030	-.033	.003	-.018	.089	-.183*	.103	-.027
ImpLP	.311*	.201*	.052	.122	.076	-.092	-.058	-.007	-.038	.056	-.189*	.220*	-.092
ImpPM	.159*	.092	.014	-.076	-.148	.106	.173*	-.063	.022	-.008	-.008	-.045	.068
ImpInv	.067	.031	-.031	-.019	-.145	.124	.173*	-.079	.023	-.039	-.067	.056	.082
ImpAHP	.116	-.025	.054	-.166*	-.132	.105	.130	-.017	.059	-.005	-.038	-.078	.061
ImpSim	.201*	.011	-.006	-.070	-.014	.028	.029	-.038	-.034	.012	.045	-.003	-.005
ImpMRP	.105	.056	.050	-.106	-.232*	.078	.247*	-.009	.068	-.044	.038	-.099	.006
ImpTQM	.051	-.005	-.060	-.198*	-.174*	.129	.211*	-.087	.107	-.049	-.012	-.112	.016
ImpDTab	.173*	.031	.065	-.029	-.066	.040	.134	-.125	-.011	.052	-.095	.032	.020
ImpTrees	.122*	.004	-.052	.011	-.026	.124	.060	-.120	.078	.038	-.218*	.011	.046
ImpEMV	.078	.070	-.030	.054	.009	.098	.021	-.107	-.120	-.023	.082	.185*	-.060
ImpGame	.074	-.065	.085	-.049	-.135	.065	.129	.014	-.016	.105	-.138*	.031	-.038
ImpSPC	.126*	.009	.049	-.171*	-.117	.081	.137	-.046	.039	-.014	-.031	-.023	.016

Table 23 continued

Variable	Spearman's Rank Correlation Coefficients													
	DSinc l0	DSinc l1	DSinc l2	DSinc l3	Council	Rank Prof	Rank Asoc	Rank Asst	Rank Lect	YrsTch 03	YrsTch 46	YrsTch 79	YrsTch 1012	DSinc l0
ImpFcst	-.024	-.217*	.208*	.054	.103	-.011	-.065	.034	.065	.091	.056	-.049	.049	-.088
ImpRegr	-.135*	-.078	.058	.115	.048	-.079	-.033	.055	.107	.109	.098	-.048	.106	-.159*
ImpDesc	-.177*	.040	.066	-.010	.004	-.183*	.041	.153*	.056	.091	.134*	.023	.050	-.172*
ImpInfer	-.043	-.017	.033	.010	-.089	.017	-.067	-.025	.092	-.099	.129*	.020	.056	-.045
ImpProb	-.048	-.098	.070	.052	.009	-.069	.003	.024	.079	-.018	.067	.035	-.012	-.035
ImpZscore	-.151*	-.013	.046	.106	-.016	-.072	-.037	.068	.082	.103	.065	.057	.094	-.191*
ImpLP	-.161*	-.090	.054	.159*	.033	-.060	-.028	.068	.051	.149*	.044	-.015	.102	-.175*
ImpPM	-.075	-.045	.092	.026	.047	-.118	-.031	.129*	.079	.078	.089	.077	.057	-.175*
ImpInv	-.040	-.106	.104	.092	.088	-.106	-.019	.061	.126*	.104	.052	-.033	.020	-.087
ImpAHP	-.009	.013	.082	-.155*	.035	.031	-.034	-.009	.005	.042	-.058	.023	.116	-.080
ImpSim	-.157*	-.055	.180*	-.056	.025	-.007	.013	.010	-.019	.060	-.049	.113	.101	-.140*
ImpMRP	-.014	-.024	.127*	-.106	.105	-.085	.037	.033	.050	.079	-.046	.070	-.007	-.066
ImpTQM	.032	.023	.015	-.059	.085	-.081	-.047	.004	.190*	.020	.020	-.031	.119	-.075
ImpDTab	-.092	-.012	.077	-.037	.063	-.067	.003	.064	.028	.097	-.076	.061	.017	-.071
ImpTrees	-.076	-.038	.064	.044	.067	-.057	-.035	.089	.031	.108	-.080	.005	.059	-.069
ImpEMV	-.057	-.180*	.187*	.054	-.022	-.002	.019	-.008	-.013	-.056	-.060	.073	-.018	.035
ImpGame	-.186*	.025	.039	.067	-.036	-.082	.038	.079	-.013	.088	.019	.027	.041	-.108
ImpSPC	-.031	.007	.016	.002	-.056	-.030	-.095	.055	.104	.073	.009	-.015	.036	-.065

Table 23 continued

Variable	Spearman's Rank Correlation Coefficients											
	YrsWork 03	YrsWork 46	YrsWork 79	YrsWork 1012	YrsWork 13up	Chair	Res Appl	Res More	COBA Und	COBA Mas	COBA Doc	COBA num
ImpFcst	.024	.035	-.051	-.017	-.025	-.117	.116	.123*	.043	-.058	-.080	-.013
ImpRegr	.103	.046	-.150*	-.033	-.074	-.109	.148*	.158*	-.015	-.007	.057	.016
ImpDesc	.144*	-.043	-.120	.030	-.116	-.171*	.223*	.116	-.062	-.048	.041	-.052
ImpInfer	.113	-.007	-.095	.020	-.116	-.136*	.149*	.023	.020	-.012	.084	.023
ImpProb	.008	.036	-.050	.001	-.013	-.094	.162*	.114	.053	.012	.082	.063
ImpZscore	.029	.049	-.076	.032	-.062	-.079	.174*	.219*	.134*	.060	.061	.133*
ImpLP	.004	.034	-.031	-.011	-.012	-.047	.189*	.214*	.123*	-.014	-.069	.037
ImpPM	.037	-.064	-.109	.054	.059	-.043	.088	-.002	.021	.094	.100	.067
ImpInv	.010	.023	-.122	-.008	.063	-.020	.026	.010	.039	.106	.122	.100
ImpAHP	-.033	.137*	-.096	-.052	.020	.062	-.022	.026	.007	.091	.034	.073
ImpSim	-.057	.043	-.049	.062	.040	-.003	.164*	.157*	.077	-.015	.039	.042
ImpMRP	-.048	.075	-.097	.066	.027	-.034	.038	.021	.052	.078	.123	.075
ImpTQM	.001	.102	-.127*	-.078	.047	.080	-.079	-.110	.088	.128*	.157*	.173*
ImpDTab	-.013	.051	-.066	.035	-.009	-.020	.078	.092	.053	.119	.047	.052
ImpTrees	.028	.052	-.127*	.007	-.009	-.026	.141*	.072	.043	.051	-.001	.020
ImpEMV	-.009	-.011	.018	-.055	.054	-.049	.122*	.029	.029	.160*	.074	.107
ImpGame	.088	.025	-.128*	-.044	-.038	-.043	.277*	.262*	.016	.058	.009	.040
ImpSPC	-.024	.017	-.108	.045	.075	-.013	.019	.091	.109	-.011	.056	.085

* $p < .05$.

APPENDIX G

FORCED-ENTRY MULTIPLE REGRESSION TABLE OF RESULTS

Table 24

R^2 Change and Explained Variation for 18 Dependent Variables

	DV	Initial Independent Variable Set	Initial R^2	Reduced Independent Variable set	Final R^2	Percent reduction in R^2	Percent reduction in IVs
1	Forecasting						
		HasDSCourse	0.100	HasDSCourse	0.080	20%	60%
		DegBSoth		DSincl2			
		DSincl1					
		DSincl2					
		ResMore					
2	Regression						
		HasDSCourse	0.184	HasDSCourse	0.139	24%	38%
		DegGenAg		DegGenAg			
		DegBSoth		DegBSoth			
		DSincl0		DSincl0			
		YrsTch13up		YrsTch13up			
		YrsWork79					
		ResAppl					
		ResMore					
3	Descriptive Statistics						
		DSincl0	0.152	DSincl0	0.129	15%	63%
		RankProf		Chair			
		RankAsst		ResAppl			
		YrsTch46					
		YrsTch13up					
		YrsWork03					
		Chair					
		ResAppl					

Table 24 continued

	DV	Initial Independent Variable Set	Initial R^2	Reduced Independent Variable set	Final R^2	Percent reduction in R^2	Percent reduction in IVs
4	Inferential Statistics						
		DegGenAg	0.066	DegGenAg	0.039	41%	75%
		YrsTch46					
		Chair					
		ResAppl					
5	Probability and Distributions						
		DegGenAg	0.065	DegGenAg	0.054	17%	33%
		DegBSoth		ResAppl			
		ResAppl					
6	Z-scores						
		DegGenAg	0.131	DegGenAg	0.115	12%	43%
		DSincl0		DSincl0			
		YrsTch13up		YrsTch13up			
		ResAppl		ResMore			
		ResMore					
		COBAUnd					
		COBAnum					
7	Linear Programming						
		HasDSCourse	0.134	None of the IVs were significant at the .05 level.			
		ReqMaj					
		DegGenAg					
		DegBSoth					
		DSincl0					
		DSincl3					
		YrsTch03					
		YrsTch13up					
		ResAppl					
		ResMore					
		COBAUnd					

Table 24 continued

	DV	Initial Independent Variable Set	Initial R^2	Reduced Independent Variable set	Final R^2	Percent reduction in R^2	Percent reduction in IVs
8	Project Management						
		HasDSCourse DeptTchDSbu RankAsst YrsTch13up	0.087	DeptTchDSbu YrsTch13up	0.078	10%	50%
9	Inventory Management						
		DeptTchDSbu RankLect	0.052	DeptTchDSbu	0.027	48%	50%
10	Analytic Hierarchy Process						
		HasDSCourse DSincl3 YrsWork46	0.072	All were significant at the .05 level.			
11	Simulation						
		HasDSCourse DSincl0 DSincl2 YrsTch13up ResAppl ResMore	0.102	HasDSCourse	0.045	56%	83%
12	Material Resource Planning						
		DeptTchDSmy DeptTchDSbu DSincl2	0.067	None of the IVs were significant at the .05 level.			

Table 24 continued

	DV	Initial Independent Variable Set	Initial R^2	Reduced Independent Variable set	Final R^2	Percent reduction in R^2	Percent reduction in IVs
13	Total Quality Management						
		IsTeacher	0.139	RankLect	0.039	72%	88%
		DeptTchDSmy					
		DeptTchDSbu					
		RankLect					
		YrsWork79					
		COBAMas					
		COBADoc					
		COBAnum					
14	Decision Tables and Rules						
		HasDS Course	0.030	All were significant at the .05 level.			
15	Decision Trees						
		HasDSCourse	0.096	DegGenAg	0.074	23%	50%
		DegGenAg		YrsWork79			
		YrsWork79					
		ResAppl					
16	Expected Monetary Value						
		DegBSoth	0.102	DegBSoth	0.050	51%	60%
		DSincl1		COBAMas			
		DSincl2					
		ResAppl					
		COBAMas					
17	Game Theory						
		DegGenAg	0.140	ResAppl	0.111	21%	60%
		DSincl0		ResMore			
		YrsWork79					
		ResAppl					
		ResMore					

Table 24 continued

	DV	Initial Independent Variable Set	Initial R^2	Reduced Independent Variable set	Final R^2	Percent reduction in R^2	Percent reduction in IVs
18	Statistical Process Control						
		HasDSCourse IsTeacher	0.034	IsTeacher	0.034	0%	50%

Note. DV = Dependent Variable. IV = Independent Variable. Variable descriptions are located in Appendix F.

VITA

Name: Lawrence Arthur Wolfskill

Address: Dept. of Agricultural and Industrial Sciences
MS 2088 Thomason 222
Huntsville, TX 77341

Education: Ph.D., Agricultural Education, 2011
Texas A&M University

M.B.A., Business Administration, 1989
Texas A&M University

B.S., Mechanized Agriculture, 1981
Texas A&M University

Professional: Assistant Professor, Agricultural and Industrial Sciences,
Sam Houston State University, Huntsville, Texas. (2010-Present)

Lecturer of Agribusiness, Agricultural and Industrial Sciences,
Sam Houston State University, Huntsville, Texas. (2005-2010)

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